DOCUMENT RESUME

ED 283 051 CE 047 540

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TITLE Microcomputers in Transit: A Needs Assessment and Implementation Handbook. Final Report.
INSTITUTION Indiana Univ., Bloomington. Inst. for Urban Transportation.
SPONS AGENCY Urban Mass Transportation Administration (DOT), Washington, D.C.
REPORT NO DOT-I-86-07
PUB DATE Apr 85
NOTE 87p.
PUB TYPE Guides - Non-Classroom Use (055)

EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS Adult Education; *Automation; Business Education; *Computer Literacy; Computer Oriented Programs; Computer Software; *Management Information Systems; Management Systems; *Microcomputers; Staff Development; *Traffic Control; *Transportation
IDENTIFIERS *Public Transportation

ABSTRACT

This handbook describes a practical step-by-step process for introducing microcomputers to small- and medium-sized transit operating agencies. The introductory chapter deals with the objective of buying a microcomputer system, the characteristics of microcomputers, microcomputer software, microcomputer system components, and issues faced in microcomputer implementation. The second chapter discusses the ad hoc, black box, rational, and incremental approaches to computerizing a transit operating system. The final three chapters deal with the following phases of automating a transit system: planning and strategy (reviewing tasks, exploring microcomputer applications, assessing software and hardware requirements, and formulating training and support requirements); initial implementation (choosing initial applications, software, and hardware; procuring them; and implementing the automation process); and additional applications (updating the plan, applying development strategies, developing an incremental application, formulating functional specifications, working with a programmer, and managing the system). The section on system management deals with coordinating hardware and applications, setting priorities, developing documentation standards, and providing ongoing support to system users. A 10-page glossary and annotated reference list are appended. (MN)

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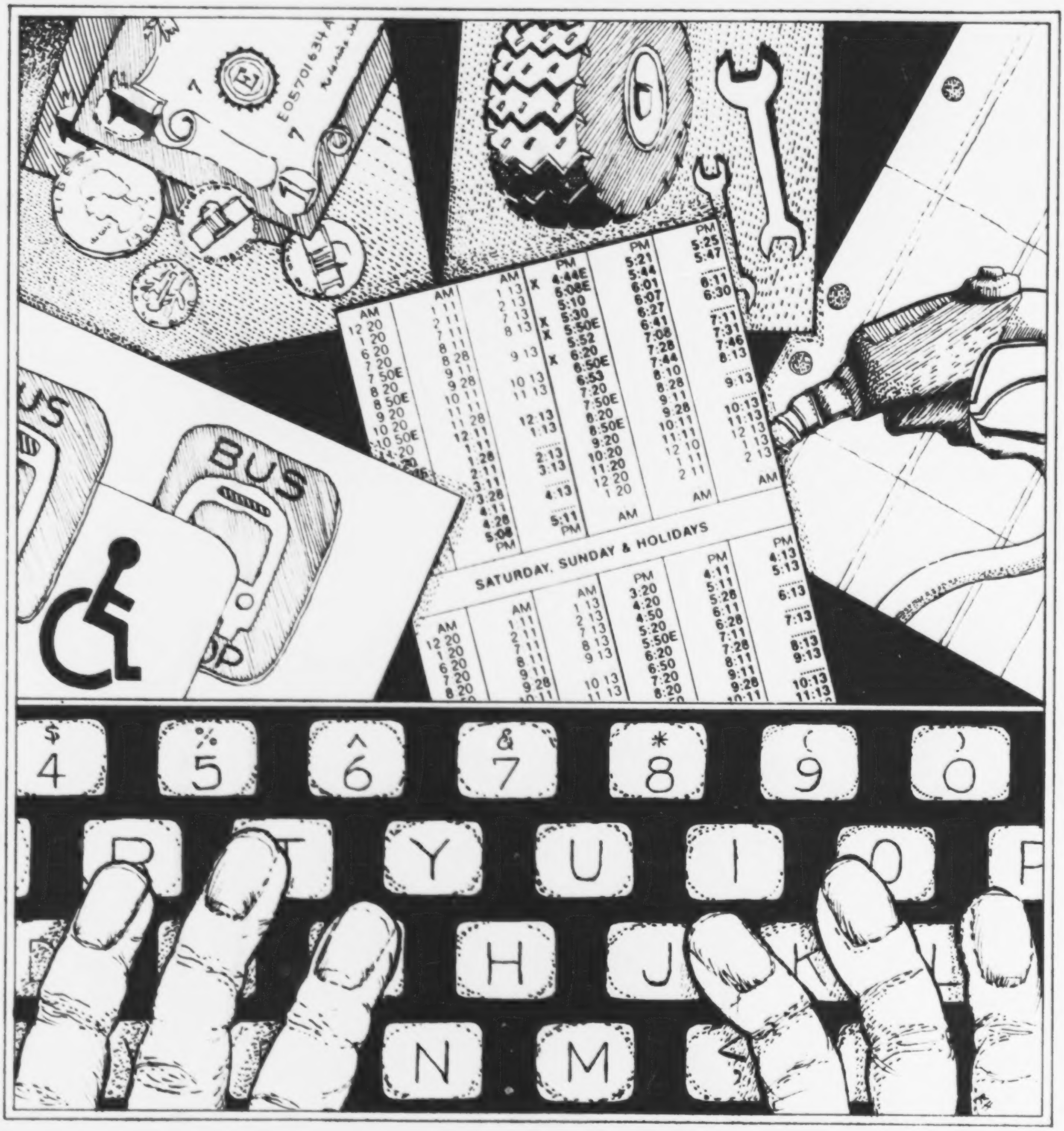
MICROCOMPUTERS IN TRANSIT

A Needs Assessment and Implementation Handbook

APRIL, 1985

ED283051



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Microcomputers in Transit: A Needs Assessment and Implementation Handbook

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Final Report
April 1985

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Prepared for
University Research and Training Program
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Distributed in Cooperation with
Technology Sharing Program
Office of the Secretary of Transportation

DOT-I-86-07

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CHAPTER ONE

INTRODUCTION

Microcomputers have much to offer the transit industry, particularly those small and medium-sized agencies that have not had access to automation in the past. They are a versatile tool with many applications, and, once introduced to an organization, can become an essential tool for everyday use. The challenge is how to get there from here.

Anyone who has thought about buying a microcomputer for home or work use knows that it is a confusing process. The range of equipment and programs is varied, and seems to change significantly from month to month. Whole new vocabularies of technical jargon are used, and can be confusing and intimidating to the uninitiated. Worst of all, it is not clear where one can get solid information on how to fill one's needs; few salespeople are truly helpful, and many people in the business are promoting their own pet products.

An equally difficult challenge concerns introducing the microcomputer to the agency in such a way that its potential as a management tool is developed. Many microcomputer systems sit unused or underused in offices around the country. The investment in staff development and systematic introduction of the technology is as crucial to the success of the project as the investment in equipment and programs.

Purpose of this Handbook

This handbook describes a practical step-by-step process for introducing microcomputers to small and medium-sized transit operating agencies. It presents an approach to the technology and the implementation problem, documented with information about specific transit applications. The handbook is complemented by two companion documents: Microcomputers in Transit: A Software Handbook, and Microcomputers in Transit: A Hardware Handbook. These handbooks provide an introduction to microcomputer programs and equipment as they apply to the transit industry.

The Objective of Buying a Microcomputer System

The only valid reason for buying a microcomputer is that it will help you to do jobs better, faster, or cheaper. When surrounded by the glamour and media hype associated with microcomputer technology it is easy to forget this basic motivation. All decisions about which product to buy, or whether to buy one at all, should depend on the fundamental question "Will this make the microcomputer more useful to the agency? "

When considering microcomputer products there are many seductions at work. New products always promise to do things that the old ones cannot. There is always a more expensive product that is faster than others or in color. Are these features really helpful to your system? What drawbacks do they bring along, such as unproven products, uncertain delivery dates, or unnecessary complexity for users of the system?

Characteristics of Microcomputers

Microcomputer systems have three major attributes that distinguish them from computers that have been available in the past,

-Similarity to traditional computers.
-Ease and flexibility of use.
-Ease of management and administration.

These are the characteristics that also make them so widely useful.

In technical terms, microcomputers are very much like tiny versions of the mainframe and minicomputers that have been in use for many years. They can store as much information, do the same operations, and work as fast as many older, large computers. Thus they can run programs very similar to the programs for which computers have been used in the past.

In one key aspect they are very different from older computers: ease of use. As small inexpensive computers with useful power have become available, more individuals and businesses have been able to afford them. As a result, programs have been designed to allow people with little or no computer experience to use them for productive tasks. These programs are easy to learn, versatile, and powerful, giving them the name "user friendly."

Another key difference exists between microcomputers and older computers. In the past computer operations were centralized. Administration was handled by an in-house computer specialist who took care of maintenance of the computer, maintained data, and coordinated various users' needs. Microcomputers require much less administration, removing the need for an in-house specialist. Some of these tasks are no longer required, others are easy enough to be done by a non-specialist staff member. Microcomputer use can be decentralized with separate machines used by various staff members, so the amount of coordination required is reduced.

Components of the Microcomputer System

A microcomputer system consists of three elements: the program or software, the computer itself with its attachments or hardware, and an operating system which links the two. These three elements are mutually supportive, and must all be compatible.

Software

The application program, or software, is the actual reason for computer use. It is the element with which the user comes into daily contact, and which makes the machine either valuable or ineffective for an application. In all selection decisions concerning the system, it is the final application, and thus the application program, which is the bottom line. A program may be purchased or obtained ready-to-use, or it may be written in a programming language by agency staff or an outside programmer for your specific purpose.

Hardware

The hardware is the tool which performs the tasks defined by the program. The core is the computer itself, made up of the microprocessor and components within the computer. Other components, called "pherals", are attached to the computer. They may include disk drives, the keyboard, monitor, printer, and additional optional equipment such as modems for communications and hard disks for data storage. The hardware items must be powerful enough to perform the tasks required by the program within the context of the agency's operation. More information on hardware components and selection can be found in a companion handbook, entitled Microcomputers in Transit: A Hardware Handbook.

Operating System

The operating system is a master program which acts as interface between the hardware and the application software. It controls the hardware as required by the program, and performs a number of fundamental tasks common to all applications. For example, when a program requires data to be printed, it tells the operating system, which then alerts the computer to send the message and data to the printer. A similar function is performed for the display screen and keyboard. The operating system includes programs which allow the user to perform a number of routine housekeeping tasks, such as copying disks. Operating systems, programming languages and utilities, which are all programs but have no actual application by themselves, are called "system software." They support the development and use of the actual application software.

Microcomputer Software

The characteristics of microcomputers are largely a result of the types of programs or software that are available to run on them. Several types of general purpose programs, referred to here as generic software, allow microcomputer users to develop their own applications of the machines for a number of common management or administrative tasks. Application programs that are developed to perform specific tasks resemble more traditional computer programs. These types of programs are described in detail in the software handbook.

Generic Programs

One of the most revolutionary aspects of the microcomputer technology is the development of sophisticated tools which can be used for all sorts of applications. There are three general types of generic programs. The most widely touted and dramatic of these is the electronic spreadsheet. Word processing has resulted in fundamental changes in the way written communications are used and is probably the first program many managers encounter. File managers have an enormous number of applications. One can learn enough of any of these to be useful within hours of first exposure. Experience with them further increases the versatility and power of their use. Other tools, such as database managers and statistical programs are equally versatile, but require more effort and experience to use effectively. Generic programs are relatively inexpensive ($50-$700 range). They require the user to set up the specific application.

Application Programs

Application software includes programs that are written to perform a particular task, such as inventory, accounting, and so on. They include off-the-shelf programs, written for a broad market of users in various businesses and purchased at computer stores, and industry-specific software developed for the transit industry.

Numerous programs are on the market to perform specific, frequently required functions. Examples of this include financial management and accounting packages, inventory, project programming, and many others. These packages are specific in their design, and are often intended for small private-sector businesses, so you must consider whether their particular characteristics are compatible with your application requirements. On the other hand they are relatively inexpensive, and, if they fit right, could be a cost effective solution.

An increasing amount of transit specific software is being developed. Sophisticated packages are available from numerous private sources for fleet management, scheduling, financial management, etc. In addition, a number of programs have been developed under UMTA funding, and are in the public domain. Although many programs of this sort are available, they may be designed for some unusual type of microcomputer, or more likely, may not be complete yet. However, with the amount of development currently underway, this situation should improve in the near future.

Specialized applications, such as particular transit management functions, have a relatively small market to support them. Within the transit industry, which is a limited market to begin with, variations in size, organization, operational environment, and other characteristics prevent one program from being directly applicable to a large number of systems. Because of the small market, the costs of developing application-specific software must be distributed between a smaller number of users, resulting in the fairly high costs of transit-specific software for all.

Issues Faced in Microcomputer Implementation

Planning and implementing a microcomputer system may seem a particularly difficult task for several reasons:

1. The technical material is complex and probably unfamiliar to transit managers.

2. Multiple interrelated decisions must be made in selecting the system.

3. Staff involved may be learning about the technology at the same time as they are making decisions.

4. Organizational as well as technical issues are involved.

Unfamiliar Technical Subject

Microcomputers have received much coverage in magazines and television. This has made people aware of the technology and its increasing use for many purposes; however, the knowledge required for planning a system is at a nuts and bolts level most easily acquired through direct experience with the equipment. Transit managers introducing microcomputers to their agency may have had little opportunity to obtain this type of knowledge.

Multiple Decisions

The person responsible for introducing a microcomputer system is faced with many interrelated decisions. The uses of the system, the way these uses will be approached, the specific programs, and specific pieces of equipment to be purchased must be selected. Many of these decisions have implications that affect other aspects of the system.

Simultaneous Learning and Decision-making

The unfamiliar and technical nature of the problem and the number of decisions that must be made mean that the person responsible is likely to be making decisions with very limited knowledge. A cycle of learning, decisions, more learning, and more decisions results.

Organizational Issues

The nature of microcomputers is such that they are likely to affect many of the people in the organization. They can be threatening as they require users to learn new skills and change their ways of doing jobs. Computer facilities are also a limited resource, for which there may be competing uses in the organization. These characteristics raise a whole set of challenges for bringing together the new system and the people in the organization, and preventing organizational problems from obstructing the effective use of the system.

Organization of the Handbook

The next section of the handbook introduces an approach to microcomputer acquisition. This approach consists of three phases: planning, initial implementation, and system development. Each of these phases is developed in detail in the chapters that follow.

CHAPTER TWO

APPROACHING THE PROBLEM

This chapter introduces several different ways of treating the microcomputer as a tool, and the different implementation strategies that are associated with each one. It suggests a strategy to combine elements of the different approaches into a process that eases the selection of the system and its introduction into the organization. This process is developed in detail in the chapters that follow.

Ways of Approaching Microcomputers

Three different approaches to procuring and using microcomputers are often used. First, the microcomputer can be obtained using an ad hoc approach, in which it is assumed that once acquired it will be useful. Second, it can be bought from or with the assistance of an outside expert who will set it up to do a particular task with limited involvement of agency staff. Finally, a systematic approach can be used to identify uses of the microcomputer and plan for its introduction.

The Ad Hoc Approach

The ad hoc approach is used by many agencies to purchase their first microcomputer. Agency staff realize that a microcomputer could be a helpful tool, and have some idea what sorts of things it could be used for. They talk to knowledgeable peers and to salespeople at their local computer store. Several different systems may be priced at various stores. Finally, they decide on a machine that seems to be appropriate, based on what they have discovered.

Once the microcomputer has been delivered and assembled in the office, the amount and purposes for which it is used depend on the initiative, interest, and time of individual staff members. Often applications are developed by a staff member who is excited by the possibilities of the machine. Some of these products may be more useful than others. On the other hand, staff may find that the amount of time necessary to learn enough to make the microcomputer useful is not available, that it is not convenient to use, or that it is too difficult to figure out how to do the applications that have been considered. Often one or two relatively straightforward applications are developed, but the knowledge or time to develop the potential of the microcomputer with additional applications is not available.

Most of the applications of the microcomputer by this approach will use commercial programs such as electronic spreadsheets, word processors, and file managers. These programs are comparatively easy to learn to use, are flexible, and have many applications in the transit operation. Despite the low level of planning and support provided by the ad hoc approach, some useful applications are likely to be developed.

This ad hoc approach treats the microcomputer as though it were a hammer, which in some ways is an appropriate analogy. It is indeed a flexible tool that can be used for all sorts of different jobs. The trouble is that it is harder to learn to use than a hammer; it takes more than just plugging the computer in to make it useful. Staff must learn how to use it, and must know what they should be doing with it. The organization may have to adjust to some different procedures. The ad hoc process may not meet these requirements and the many other complications of introducing change to an organization, with the result that the microcomputer may not be used effectively.

The Black Box Approach

For some organizations the computer is treated as a black box--something they accept and use but do not understand. Agency staff may have some problem or application that they feel will benefit from the use of a microcomputer. Recognizing that they do not know how to develop the application themselves, they decide to buy a program, a microcomputer to run it on, and the services of a consultant to install it in the agency.

The outcome of this process is a microcomputer that is used for one or more predefined tasks that it may do very well. However, it is likely to be perceived by agency staff as dedicated to that one application. As a result, the many other applications that it could be used for are not developed. In addition, the product selected for one purpose may turn out not to be adaptable or appropriate for other tasks.

The approach treats the microcomputer as though it were a tool for only one specific task. It does that one thing very well, but is not good for much else. In fact microcomputers are very versatile, so this black box approach may be limiting.

The Rational Approach

A third approach used in some agencies is the systematic or rational approach. In this approach agency staff recognize that there may be many uses for a microcomputer in the agency, and that it is a somewhat complicated problem to introduce one so that it is used effectively. To plan an orderly introduction of automation to their agency, they hire someone who is familiar with both microcomputers and the transit industry to do a needs assessment. This study identifies the best uses of a microcomputer in the agency, and what type of programs and equipment are needed to do them.

This approach is likely to result in the implementation of a variety of microcomputer applications including those on commercial packages, and others requiring a specific program or custom developed program. Appropriate training is likely to be provided for agency staff to make good use of the microcomputer, and the various organizational issues related to implementation are addressed.

This approach treats the microcomputer as a tool box containing a variety of applications. Some may be simple ones that could have been developed in-house using the ad hoc approach, and others resemble black box applications. The benefit of this approach is that it can help the agency to get the most out of its microcomputer. The drawback is that it is time-consuming and expensive.

An Alternative: The Incremental Approach

The three approaches described above all have their benefits and drawbacks. The difficulty is to find a strategy for microcomputer introduction that is realistic to implement and combines the benefits of these different approaches.

The Problem

One of the most valuable characteristics of microcomputers, as mentioned earlier, is that they can be a flexible, versatile tool controlled by the user. Agency staff must develop a certain level of familiarity, expertise, and comfort with the machines to take advantage of this.

On the other hand staff at most transit agencies interested in buying a microcomputer have little knowledge about the machines. This results in one of two approaches. Possibly they forge ahead, with what knowledge they are able to pick up, in faith that the technology will be useful to them (the ad hoc approach). Alternatively, they pay an expert to introduce the technology for them, and take a more passive role (the black box and rational approaches). Neither of these solutions to the problem provides sufficient support for agency staff to learn to make active personal use of the computer for a variety of applications.

The Solution

An alternative strategy, the incremental approach, is designed to support the development of effective roles for the microcomputer in the agency. This strategy combines elements of the ad hoc and rational approaches to allow agency staff to make the most of the technology while following a systematic plan to shape the ultimate role of microcomputers in the agency.

This can be accomplished by starting with a modest system and developing those applications that are easiest to do in-house using commercial programs. Once these basic applications are established, additional more complex ones can be added. By this time a foundation of knowledge will have been developed that helps agency staff to work more effectively with outside programmers or consultants when they are required.

This strategy differs from the rational approach in the rate of implementation, and the reliance on outside expertise. Applications are implemented only as fast as they can be incorporated in the agency's operations. Development of in-house expertise is encouraged, allowing more active use of the microcomputers directly by agency staff, and more effective use of consultants and programmers for development of complex applications.

The Incremental Process

A practical process for guiding the introduction of microcomputers in a transit agency consists of three phases:

1. Planning and strategy.
2. Initial implementation.
3. System development.

Each of these phases consists of several steps, which are illustrated in Figure 2.1, and described in detail in the following three chapters.

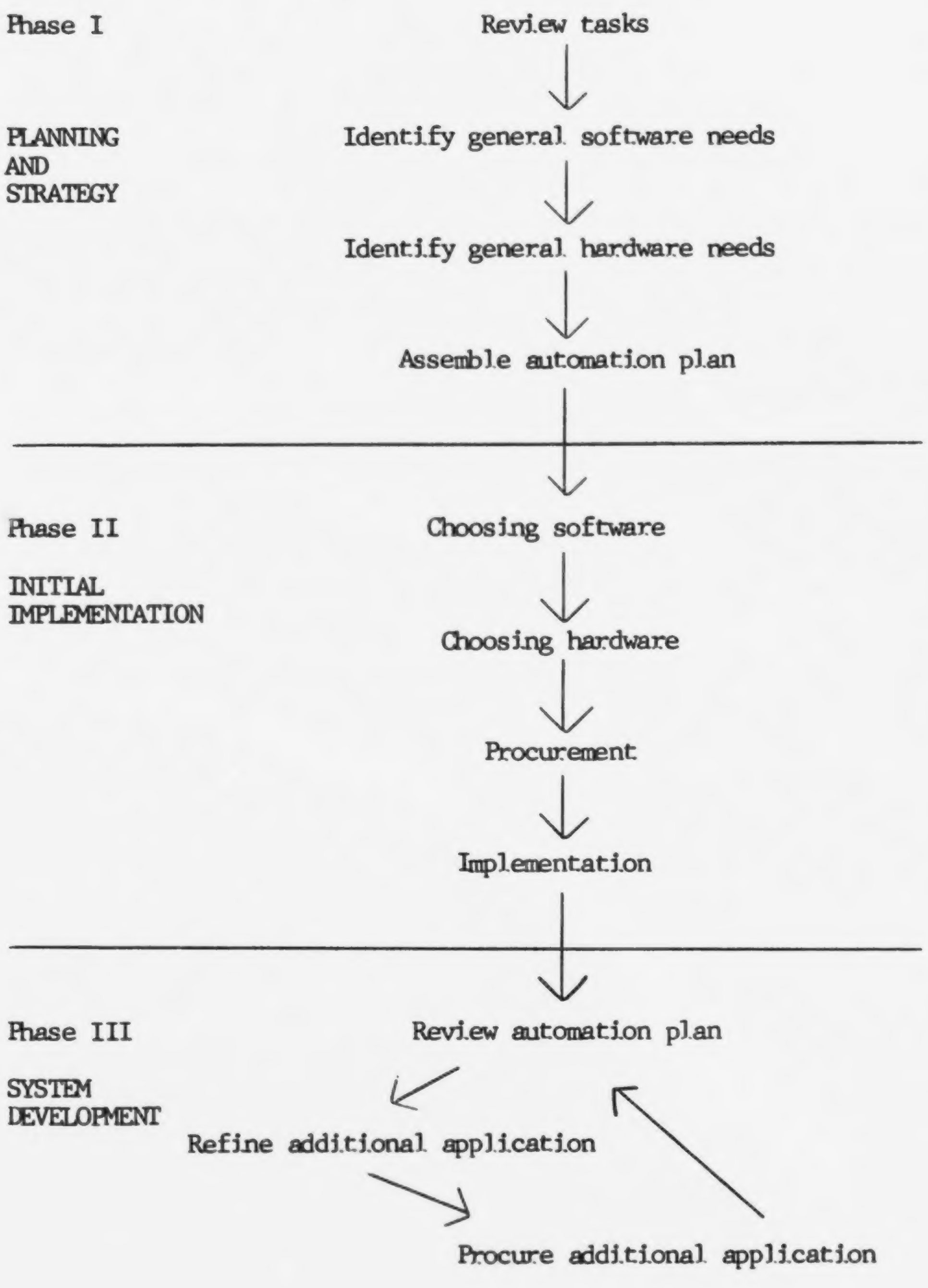
Phase I
PLANNING AND STRATEGY
Review tasks
Identify general software needs
Identify general hardware needs
Assemble automation plan
Phase II
INITIAL IMPLEMENTATION
Choosing software
Choosing hardware
Procurement
Implementation
Phase III
SYSTEM DEVELOPMENT
Review automation plan
Refine additional application
Procure additional application

FIGURE 2.1 The Incremental Process.

CHAPTER THREE

PHASE 1: PLANNING AND STRATEGY

The first phase of the incremental process involves preparing an automation plan. Development of an overall strategy is essential to prepare for the selection and effective use of the microcomputer. Many of the most difficult issues related to microcomputer implementation are not technical ones, but concern the logistics and organizational aspects of introducing the machine in the agency. This plan provides an opportunity to address these issues early, so that they do not later create a barrier to the project.

The automation plan should not be a very technical document, and can be done by agency staff. A minimal level of previous experience with microcomputers is required by the staff member responsible. This could be obtained by reading some of the documents available from UMTA, by visiting an organization that uses microcomputers, or by attending a course on microcomputers.

Phase 1 of the process includes four steps:

1. Reviewing tasks.
2. Identifying general software needs.
3. Identifying general hardware needs.
4. Assembling the automation plan.

Reviewing Tasks

The first step in assessing needs is to review the various jobs in the agency that the microcomputer could be used for, and to identify what, if any, benefit there would be in using one for each job. This requires understanding what types of activities a microcomputer can actually be useful for, and what benefits the agency might get as a result. Each task can then be examined to identify how a microcomputer might apply to it.

What Good is a Microcomputer?

There are three things that a computer does well:

1. Long calculations.
2. Repetitious tasks.
3. Data organization and retrieval.

Long calculations. A computer is very good at long tedious numerical calculations. An example of this would be reducing a month's ridership data to summary statistics such as average weekday, Saturday, and Sunday ridership. Calculations that are appropriate for computerization are usually either complex ones that would take a long time to accomplish manually, or extensive chained calculations where one set of numbers must be manipulated in several different ways.

Repetitious tasks. Computers are also excellent at repetitious tasks. A task that must be repeated daily or weekly, such as calculating fuel consumption for each vehicle, may be appropriate for automation. The computer will very quickly repeat a calculation from a number of different starting assumptions you want to test. This allows you to evaluate different scenarios. For example, an operating budget can be recalculated to show the cost of several alternative amounts of service offered. A similar process can be used to solve some problems by trial and error, or to produce various versions of one document or analysis.

Organization of information. Large amounts of data can be stored in an organized manner, and retrieved in the desired form very quickly. This ability allows the user to approach data in a much more flexible manner than is possible by hand. The same set of work order data, for example, could be used to summarize the use of various components, labor costs for completing various tasks, maintenance costs per mile for each vehicle, failure rates for each part, or other information. Although the same information is available from manual work order records, too much work would be required to extract it. This characteristic of computers is most useful for managing records that are accumulated on a daily or weekly basis, or for working with large bodies of information that must be updated or summarized.

Benefits to the Agency

Benefits from automation can be summarized as:

1. Time savings
2. Increased flexibility
3. Additional information

It is difficult to quantify benefits or translate them into dollar values. It is also hard to predict the actual effect of introducing microcomputers to a task in an organization. However, it is possible to list the potential benefits of automating a given process. For example, specific reports produced may be valuable to decision-making, or the ability to test assumptions may save someone hours of tedious work. This helps to create realistic expectations about the benefits of microcomputers, select the most worthwhile applications, and avoid morale-dropping disappointments.

Time savings. The speed with which the computer can calculate and sort information may allow the user to do some existing jobs faster than would be possible by manual techniques. This may reduce the burden of the mechanics of a task, and allow the user to concentrate on the data, the process, and the quality of the result. Time saved may allow tasks to be performed better and more completely, but is unlikely to result in lower staff requirements.

Increased flexibility. Time savings may give the user increased flexibility in doing a task. For example, by saving time in evaluating a projected scenario, the user may be able to consider a range of alternatives in the time it previously took to evaluate a single one. The numerous assumptions in a budget, for example budgeted amount of service, projected fuel cost, and wage rate, can be changed to examine the effects of different assumptions on expenses. The speed with which data can be reorganized and sorted may allow several different summary reports to be produced for different purposes. This increased flexibility can be a valuable asset for decision-making staff, who can consider a wider range of alternatives and ways of looking at data with little additional effort.

Additional information. The third benefit of microcomputers is the additional information they make available to managers, which may be used for more thorough analysis of problems and better decision-making. For example, employee safety and discipline records can be sorted to identify eligible candidates for a safety incentive award, a task that would previously have been time consuming. This information usually takes one of two forms: either a variety of reports can be produced routinely, summarizing information in different ways for different purposes, or special summaries can be done as required to answer particular questions.

Reviewing Tasks

Each task that is a candidate for automation should be examined to see whether it includes elements that a computer could do well, such as long calculations, repetitious tasks, and data retrieval and organization. Other characteristics that make it particularly suited for automation, or that are likely to complicate its automation should also be considered. These might include organizational procedures, staff potential or operating difficulties.

The questions in Figure 3.1 provide a general guideline for reviewing each potential application in the agency. The first three categories of questions help to identify whether benefits might be obtained from automating the application. The fourth and fifth types of questions can be used to identify constraints that might apply to automating that application.

Task analysis. Task analysis should provide a fresh look at the task in the context of automation. Breaking down a task into subcomponents or steps helps to identify elements of the application that could benefit from automation, as well as those that would be difficult to automate. In some cases a microcomputer could help with certain steps of the task, without the entire application being automated.

Procedure. The framework within which the task is done may affect the usefulness of the automation. Procedures that are fairly routine may be more amenable to automation than changing procedures. An analysis that is rarely performed, or that is done differently each time, may be more trouble to set up or change than the benefits are worth.

Potential improvements. A wish list of desired improvements, and problems that might be solved by automation can be listed under potential improvements. These are likely to include applications of the benefits listed above, time savings, flexibility, or additional information; all of which a microcomputer might provide. Other improvements might be such things as a more organized procedure or better communications between functions, which would not necessarily be provided by a computer system.

Information flows. Many apparently simple tasks are more complex than they appear because of the flows of information required, or because of interrelationships between the task and other functions. Data from several different sources may be required to produce one report. The form of information provided for the task may not be suitable for entering directly on the computer; it may be disorganized or inconsistent. Predefined reports may be required as output from the task, with different formats required for different purposes. Data may be obtained from, or input to, related automated applications. These constraints must be considered in estimating how complicated an application will be and in designing the application.

Staff issues. Finally, a key element in the practicality and success of any application is the person or persons who are responsible for it. This factor may also affect the development of the system as a whole, which must build on the strengths of the personnel available.

What to Look For

The questions discussed in the preceding section provide a framework to decide whether an application is suitable for automation in your agency. Some of the key issues to consider follow.

Category	Task Description	Task Needs
Task Analysis	What steps does it include? How long does each step take? How much information is involved (How many accounts, parts, employees, etc.)?	Do steps involve long or repetitious calculations? Are large amounts of data used? Might time be saved by automations? Is judgement required? Would a computer manage the information better than a manual system?
Procedure	How often is it done? Is it revised or modified each time?	How much time would be saved annually?
Potential Improvements	Could performance of the task be improved? Does the information involved have additional untapped uses?	Could automation help produce more timely completion, more complete analysis, or more accurate results? Does the current process include obstacles to automation? Would automating the process give users access to additional information of value to management?
Information Flows	Where does the input information come from? In what form is the information entered? Where does the output go? What output is required?	Is data coming from or going to another process? What type of data input is required? What reports or other output are required?
Staff Issues	Who does it?	Is he or she receptive to using the micro? Will he or she take initiative in developing and implementing the application? Could he or she provide support to other staff members?

FIGURE 3.1 Reviewing Tasks

The existence of a process. If a task is not presently done systematically and a structured process does not exist, it may not be appropriate for automation. For example, if your current inventory system does not have an adequate part numbering system, the first step in automating it would be to develop one. This would mean that the change required for automation would include changes to the task as well as all the changes required by the automation project alone, making the project more difficult.

Identifiable benefits. Although it may not be possible to quantify the benefits obtained through automation, a list of anticipated benefits should be made. These could include projected time savings to accomplish the existing task (taking into account the additional time required to enter data into the computer or program), specific information or reports that will be made available, or changes to analysis that will be possible due to the automation. If benefits cannot be identified, the task should probably not be automated.

Complexity. The more complex a problem, the harder it will be to automate. Maintenance management, for example, can be a complex process. Data is required on inventory, servicing, vehicle histories, work orders and other items. Numerous reports may be produced on maintenance scheduling, parts reorder requirements, labor productivity, fuel consumption, and other issues. Staff involved include maintenance management, mechanics, servicing staff, stockroom supervisors, and clerical staff. As a result, implementing a maintenance management system requires far more than installing a technical product. The complexities of staff and organizational issues must be dealt with, along with fitting the automated system to the organization's procedures.

Staff potential. The introduction of automation to an agency involves a massive learning process as each staff member learns how to use the new system. Some individuals may take to it readily, exploring beyond their immediate needs to satisfy their curiosity. Others may learn what is necessary to do their jobs effectively. Still others will resist the change, and may believe that it is beyond their capabilities. The ease of automating a specific task will depend on the attitude of the individual(s) involved in that task. Likewise, the ease of introducing microcomputers to the agency will depend on the strategy that is taken to develop each user's potential, and support them in becoming familiar with the change.

Transit Microcomputer Applications: A Summary

In the few years since transit agencies have begun to make use of microcomputers, many different applications for them have been developed. Some tend to be fairly uniform across the industry. Those that are complex are often developed by outside software developers and consultants, which produces a degree of uniformity between products. Other applications, particularly those that can be developed in-house using versatile microcomputer tools, vary widely as they are tailored to the procedures in use at each agency.

This section briefly summarizes a selection of transit microcomputer applications, listed in Figure 3.2. This list is not exhaustive; individual agencies develop applications in response to their specific needs. It provides an overview of the roles that microcomputers can play, and a starting point for reviewing tasks as part of a needs assessment.

Financial Applications

Microcomputers have been most widely adopted in transit agencies for financial functions. One reason for this is that staff in finance and accounting departments are likely to have some exposure to computers already, and to be receptive to the idea of introducing microcomputers. Another is that many financial procedures and analyses are already well structured, making them readily transferable to microcomputers. A third reason is that spreadsheets, which were a major cause of the rapid adoption of microcomputers, are particularly appropriate for numerous financial tasks.

Budget development. Budget development is often one of the first applications of microcomputers in transit. It is a natural application of spreadsheets. (See the Software Handbook for an example.) The user specifies formulas to calculate individual line item costs, and makes direct estimates of other line items. Assumptions about projected unit costs, amount of service, and other items used in the formulas are input. The spreadsheet calculates the results of the formulas, line and column totals and subtotals. Desired performance measures and statistics (budgeted cost per hour or mile, percent of budget by line item, etc.) can also be produced. Since the spreadsheet will rapidly recalculate these things, a variety of assumptions can be tested, and the budget can be easily revised. Another benefit of this application is that the budget can be printed out in various forms, with more or less detail, as required for each purpose.

Deficit allocation. Allocation of operating deficits to several jurisdictions is a straightforward application of spreadsheets. The user initially specifies formulas to be used in allocating the deficit, or assessing local contributions, from each jurisdiction. Each time that the allocation is performed, the necessary input data (usually cost and service data) for the time period is input. The spreadsheet calculates service by jurisdiction, distribution ratios, and distributed deficit amounts. Because the spreadsheet is such a flexible tool, it can be tailored to suit the structure of each agency's financial arrangements and the form of data used to calculate the distribution.

Cash management. A spreadsheet can be used to maintain data on projected and actual cash position, and to assess borrowing and investment decisions. (See the Software Handbook for examples.) At the beginning of the year, the user enters projected cash inflows and outflows. As current actual information becomes available it replaces the initial projections. The spreadsheet calculates the current and projected cash

Area	Task	Type			*Benefits*		
		Calculation	Repetition	Data Organization	Time	Flexibility	Information
Finance	Budget development	*	*		*	*	
	Deficit allocation	*			*		
	Cash management	*			*	*	
	Fare revenue	*			*	*	
	Physical inventory			*			*
	Monthly reports	*	*		*		*
	General ledger		*	*	*		
	Accounts payable		*	*	*		*
	Accounts receivable		*	*	*		*
	Payroll		*	*	*		*
Operations	Operating docs		*		*		
	Bus stop inventory			*			*
	Scheduling		*	*	*	*	*
	Timekeeping	*	*	*	*		*
Maintenance	Tire inventory			*			*
	Oil analysis			*			*
	Ad management			*	*	*	
	Parts inventory	*	*	*			*
	Veh histories			*			*
	Mtce schedule		*	*			*
	Daily servicing	*	*	*			*
	Purchasing	*		*	*		*
Planning	Rev and ridership	*	*	*	*		*
	Service allocation	*			*		
	Trip ridership	*	*	*	*		*
	Route profitability	*			*		
	Survey processing	*		*		*	
Administration	Document preparation		*		*		
	Personnel admin			*			*
	Operator records			*			*
	Pass/token admin	*		*			*
	Accident analysis			*			*
	Claims tracking			*			*
	Labor bargaining	*	*	*	*	*	*
	Report transmission						
Human service	Client registration			*			*
	Booking/scheduling		*	*			*
	Reporting/billing	*	*	*	*		*

FIGURE 3.2 Typical Microcomputer Applications for Transit

balances based on the most recent information input. The cash manager can also enter investment opportunities in the spreadsheet in order to see the effect of the decision on the agency's cash position. Used this way, the application is an ongoing aid to management decision making.

Fare revenue projection. Analysis of projected fare changes is an example of the flexibility that some microcomputer applications can provide. Projection of fare revenues and ridership changes after a fare increase can be a tedious task when it is done manually. The formulas used may be confusing, and it is difficult to test all the fare structures that may be under discussion. As a result of these considerations, and the uncertain value of the elasticities (which measure the sensitivity of ridership to fare changes) used to project ridership losses, the effects of fare changes are often not analysed.

Spreadsheets help with this problem in several ways. First, they present the analysis in a structured way that clarifies the technique and makes it easier to explain to others. Second, they allow rapid calculation of projected fare revenues and ridership losses. Finally, the speed of calculation permits the user to try a range of assumptions about future fares and rider sensitivity to fare increases, which clarifies the impact of uncertain elasticity assumptions.

The user sets up the spreadsheet with the fare categories used and the elasticity formula. (See the Software Handbook for an example.) Data is entered on current fares, current ridership, assumed elasticities, and future fares. The spreadsheet calculates the future ridership and resulting future revenue.

Another strategy for projecting ridership and fare revenue is to develop a formula that calculates ridership or fares based on those things that affect it. For example, ridership may depend on the amount of service offered, the fare, local economic conditions, or the year. Regression analysis (a statistical technique for finding the line of best fit) can be used to find the formula that best shows the relationship between ridership and these things if this information is known for long enough in the past. Various generic programs, some related to spreadsheets, can be used to do the regression. Although these make the mechanics of the regression very easy, the user has to understand the technique well enough to use the results correctly.

Fixed asset inventory. Information on fixed assets can be maintained using a file manager or database manager. Data on the purchase price, disposition, and depreciation status of each item can be maintained. Reports that can be produced include the status or value of selected groups of items or specific assets. This application is relatively independent of other financial applications, and is therefore not too complicated to implement.

Accounting. Accounting functions can often be performed with the help of a business accounting package. These programs are written for small businesses, and may not fit the needs of a transit agency completely or may need to be modified. The programs can usually be purchased as modules, designed to work together. At the heart of them is the general ledger module. Other modules usually include accounts payable, accounts receivable, payroll and inventory. The general ledger, accounts payable, and accounts receivable modules are most likely to be applicable to a transit operation. The payroll and inventory modules may need major modifications to make them suitable.

The shift to an automated accounting system is more complex than the applications discussed previously. General ledger is closely integrated with other accounting applications, such as accounts payable, inventory and payroll, which are in turn linked to maintenance management and operator timekeeping. If these other applications may be automated, each accounting function cannot be developed in isolation. The requirement for accuracy and auditability may also complicate automation of accounting. Duplicate procedures must be maintained until the new system has been shown to be working properly, and special attention must be paid to the ability to audit the system.

The general ledger module is linked to the other modules in the system so that changes made in one will be automatically transferred to the other. It provides a framework of books and journals like that of a manual accounting system, and generates standard reports at the appropriate times. These usually include trial balance, income statement, balance sheet, and transaction detail.

The accounts payable function is provided as a module of business accounting packages. Invoice information is entered, and the package schedules payments and prints checks. A number of reports are generated including open invoices by vendor and due date, aging of open invoices, cash requirements, check register, and transaction detail. The function should be integrated with the general ledger module, allowing entries to be posted automatically to the appropriate general ledger account.

Many transit operations have little need for accounts receivable, unless they do charter work, have an extensive pass sales program, or provide human service transportation. An accounts receivable module is usually available with a business accounting package. Customer account charges and receipts are entered, and the package generates required reports including aged accounts receivable, account statements, cash receipts journal, transaction detail, customer mailing labels, and customer lists. An integrated package will automatically post receipts to the appropriate general ledger account.

Payroll (gross to net processing). Most business accounting packages include a payroll module, which processes the necessary deductions from each employee's pay and generates paychecks. The labor intensive nature of transit operations results in a large amount of data that has to pass from operations (dispatching and timekeeping) to payroll. Paid time must be calculated from the various types of time worked. It is desirable to provide for this, either by modifying a payroll module, or by developing a separate timekeeping package that produces the information required by the payroll module in the correct format.

Many agencies have payroll prepared by a bank or service agency. These institutions often provide payroll service at low cost to draw in customers. The costs and benefits of doing payroll in-house should be compared with having it prepared by a service agency.

Operations Applications

Many of the possible microcomputer applications in the operating department are complex and specific to transit operations. As a result, programs written specifically for the transit industry may be required to do these functions.

Operating documents. Either a spreadsheet or a word processor can readily be used for preparing operating documents such as paddles, headway sheets, and dispatch sheets. Spreadsheets are more appropriate for table-like documents that may include some calculations, while a word processor can be used for either tables or less structured documents. (See the Software Handbook for examples.) Once the document has been prepared on the microcomputer, revising it is a relatively minor operation.

Bus stop inventory. An inventory of bus stops can be maintained using a commercial file manager or database management package. Data can be entered on the number, location, routes, boardings, alightings, and amenities for each bus stop. When this information is needed the user can generate a report such as a list of all stops on a particular route, a list of all stops with shelters, or a list of stops with a high level of passenger activity.

Scheduling and runcutting. The type of automation that is helpful to the scheduler varies depending on the size of the system and the type of service offered. For many small operations the main benefit provided by a scheduling aid is to perform the mechanical functions of filling in time points, editing paddles or run guides and so forth. Larger systems may require more assistance with organizing and managing data, such as block information, runs cut, and remaining pieces.

Several low cost techniques to help with the mechanics of scheduling are available on microcomputers. These include schedule generation programs (available free from TIME, Appendix B) that build schedules and fill in time points by building and modifying blocks. Spreadsheets can also be used as a schedule building aid. (See the Software Handbook for examples.)

Several more expensive, proprietary transit scheduling programs are available from consultants and programmers. These perform the runcutting function and prepare various resulting documents. Some also perform blocking. They allow the operator to specify constraints imposed by work rules on the runs, and to intervene as desired in specifying the order of runs cut.

Operator timekeeping. Timekeeping can be assisted by various tools, depending on the size of the agency and the degree of automation of related functions. At the simplest level, spreadsheets can be used to calculate time paid for each piece of work. This information would be transferred manually to the payroll calculations. If an automated system is in use, a custom program may be written in a programming language such as BASIC or using a sophisticated database management system. Such a program could input timekeeping information directly into the payroll program without manual transfer.

Maintenance and Inventory Applications

There are many applications in maintenance and inventory that are very appropriate for microcomputer use. The large amount of data that is generated daily on parts inventory and use, vehicle servicing and maintenance work orders can be organized using the computer. Once these data bases have been set up, the data can be used to produce numerous reports to assist maintenance management such as part use, labor productivity, failure rates and patterns, and others.

The automation of these maintenance management records is complicated by the many interrelationships between data. Parts inventory information, for example, is linked to work orders as parts are issued and installed. For many purposes it may be helpful to automate each type of information separately using a simple database or file manager. In a large operation it is worthwhile to integrate all information in a comprehensive maintenance management system.

Many productive uses of maintenance data can be accomplished by organizing information on a simple commercial database or file managment package. If a more comprehensive system is required, a number of proprietary maintenance management systems are available from consultants and software developers. These programs are designed to be ready to use, usually offer the user a menu of functions to choose from, and can produce a variety of standard reports combining data from different functions.

In addition to these relatively complex maintenance applications there are many straightforward spreadsheet and database applications in maintenance management. Tire mileage calculations, oil analysis tracking, and advertising management are examples of easily understood applications that may demonstrate the benefits of microcomputers in the maintenance area.

Tire inventory. Tire use can be tracked for lease administration purposes using either a spreadsheet or a simple database manager. Data on mounting and removal of individual tires can be maintained, with the microcomputer calculating mileage run automatically. Alternatively, mileages can be calculated for each vehicle each month, and multiplied by the number of leased tires on the vehicle to generate the billed mileage.

Oil analysis tracking. Results of routine oil analysis tests can be tracked over time using a spreadsheet. If results of individual tests are entered, the data for a single vehicle on metal content and oil additives can be graphed to show trends over time.

Advertising management. Installation and removal of advertisements can be made more efficient by using a database manager to record which ads are in place on each vehicle. This system can be used to print out a list of vehicles on which a particular ad is to be removed, or to list slots available for installation of a new advertisement.

Parts inventory control. Depending on the size of operation, a more or less sophisticated inventory system may be appropriate. A simple inventory system, developed in-house, can be used to keep track of the status of individual parts and trigger and track orders. Because this system stands alone, without connections to accounts payable or maintenance data, it cannot be used to track parts use by time or vehicle, nor to value the inventory in stock. (A limited application for parts inventory, using a file manager, is documented in the Software Handbook.)

More comprehensive parts inventory systems may be included either in a maintenance management package or as part of a business accounting package. Daily information on parts received and issued is entered in the system. If a maintenance management system is in use, parts issued could be included in work order data entered for both the inventory and maintenance management systems. The system will then assign parts issued to the vehicle on which they were used, cost parts used, generate a report of parts to be reordered, value current inventory, and provide current information on the number and use of any part. If an accounting system is in use, the inventory system may automatically post the cost of parts used to general ledger. The list of parts to be reordered may be used as input to an automated purchasing system that identifies suppliers and generates purchase orders.

Inventory systems are often included as a module of business accounting packages. Usually these systems are intended for sales inventory and profit analysis, rather than manufacturing and production as required by transit maintenance operations. Some of these modules can be modified to allow data to be transferred between inventory and other functions such as maintenance work orders, vehicle histories, and purchasing.

If inventory is associated with a maintenance management package, it may be desirable to provide connection with the accounting functions. Specifically, the cost of parts used may be posted to the appropriate general ledger account, and reorder information may be coordinated with purchasing and accounts payable.

Maintenance management. Vehicle maintenance management involves a number of sets of information that are all interrelated. These include information on vehicles in the fleet, work orders, and daily servicing records. If this information is maintained in the computer, a number of useful reports can be prepared, including maintenance scheduling, mechanic labor use, parts usage by vehicle, vehicle fuel and oil consumption, and individual vehicle histories.

The amount of interrelated information makes maintenance management a fairly complicated application to implement. In addition to the amount of data that must be organized, the system must be part of daily maintenance procedures to ensure that data is kept accurate, complete, and up-to-date.

Limited maintenance analysis can be done by setting up individual sets of data on a file or database manager. However, in order to make the most of the large amount of maintenance-related information that is kept, a comprehensive system in which the various pieces of information can be combined is required. A number of proprietary maintenance management systems are available from consultants and software developers. Some of them are written in regular programming languages. Others use database management packages. In general, it is easier to make minor changes to a package written in a database management language than a programming language.

Purchasing. Purchasing may be handled as part of the inventory function, or may be an extension of that function. A simple purchasing system can be developed on a database management package, linking information on reorder needs, vendors and prices, and producing purchase order data for input to the accounts payable system.

Service Planning Applications

There are many applications of microcomputers in the planning functions that are independent and straightforward to implement. Many types of one-time analyses and routine reports can be prepared on spreadsheets. Ridership data can be managed on spreadsheets or file managers.

Revenue and ridership reporting. Ridership analysis can normally be performed by means of a spreadsheet. This strategy provides ample flexibility to accommodate the specific agency's data collection and analysis procedure and to produce the specific reports required. (See the Software Handbook for an example.) Data can be entered on driver counts for each run, farebox revenues for each block, or whatever form of data is currently collected. The formulas for converting this data into ridership by route are stored in the spreadsheet. The spreadsheet will then calculate ridership totals by day, and by route.

Scheduled route mileage/hours computation. Spreadsheets can be used to calculate the amount of service provided by route or jurisdiction. Total run or block times are entered, along with the proportion or amount of time to be allocated from that run or block to each route. The spreadsheet will perform the necessary additions. Hourly or mileage costs can also be specified, resulting in a cost allocation by route. Once developed on this format, revisions can easily be made when the schedule or runcut is changed.

Trip ridership analysis. Data collected during on-board on-off counts can be summarized for Section 15 reporting or trip-by-trip ridership analysis using spreadsheets. On-off counts for each trip are stored in a spreadsheet. Trips can be selected by day or time period as required, and the spreadsheet will calculate average boardings and alightings by stop for that period. Other performance measures can also be calculated as required.

Route cost/revenue analysis. An example of the type of infrequent analysis that can be performed using spreadsheets is cost/revenue analysis. The spreadsheet contains formulas for estimating service cost based on hours and miles of service, deadhead time, number of vehicles in service, or other measures. Revenue is estimated based on ridership and fares. The spreadsheet can then be used to calculate the cost of each route and the revenue it will generate, and to test various assumptions about amount of service, fares, and ridership.

Ridership survey processing. Programs have been developed recently that make statistical analysis on microcomputers comparable to statistical analysis formerly done on mainframe and minicomputers. These programs give the user more flexibility in analyzing ridership and attitudinal survey results than was previously available. In addition, results can be obtained much faster. The person using the program should be familiar with the statistical analysis techniques, but the programs do not require a lot of computer expertise to set up and use.

Administration Applications

Many administration tasks are common to most organizations. As a result there are many easy-to-use programs that help with administration functions.

Document preparation. One of the most common uses of microcomputers is for document preparation using a word processing program. Because these programs were among the first to be widely used on microcomputers, they have undergone various revisions, and many excellent competing programs are now available for this purpose. Word processing is one of the easiest ways to introduce microcomputers to an agency, and allow staff to become familiar with the technology.

Word processing is most valuable for preparing and revising lengthy documents. Corrections can be made easily, preventing retyping of previous drafts. A completed document can be revised with a minimum of additional typing. The many uses for this in a transit agency include preparation of labor contracts, specifications, reports, and operating documents, as well as routine memos and correspondence.

A second use of word processing is for mailing list maintenance and mass mailings, which can dramatically change the agency's communication with the community. Word processing makes it feasible for any sized agency to prepare mailing labels and personalize letters for large mailings. This can be useful for distributing a newsletter to members of the community, passholders, or clients of human service transportation providers.

When planning to use a microcomputer for word processing, the amount of time that it will be used for that function should be considered. Depending on the amount of typing done in the agency, the computer could be occupied full time with word processing. This possibility should be planned for in selecting uses of the computer, and limitations may be established on what word processing should be done on the microcomputer.

Personnel records. Maintenance of the many records and files associated with personnel and benefits management can be a useful microcomputer application. Personal information as well as benefits records such as health insurance and time off can be set up and maintained using a commercial database or file manager. This allows information on any employee to be retrieved quickly and updated easily. Summaries of use of benefits and EEO data can be produced conveniently as required. The information can also be used to produce mailing lists and personalized letters to selected employees.

Operator records. File or database managers can also be used to maintain data on operator performance. Incidents such as accidents, write-ups, disciplinary action, complaints, and commendations can be entered as they occur. This allows supervisors to quickly view a summary of the operator's performance. The data can also be summarized and sorted in order to screen employees for safety and performance awards.

Pass distribution administration. Pass or token distribution through a network of distribution outlets can be managed with the help of a database manager. Information on each outlet such as address, phone number, and contact person can be stored for rapid reference and production of mailing labels. Data can be entered for each transaction, such as distribution of a consignment of passes or receipt of payment for passes sold. Reports produced from this system would include summaries of the current number of consigned passes by outlet, histories of pass sales by outlet, and lists of outlets needing additional passes.

Accident records. Detailed reports on accidents can be summarized on a database manager. Information including location, type of accident, operator route, and extent of damage is included in the summary. This data allows accident information to be summarized as required for monthly or annual reporting. Patterns in accident occurence can be identified for use in developing accident prevention programs.

Claims tracking. The status of insurance claims are tracked and monitored using a database manager. Data on the claimant, incident, and dates of stages of claims processing is entered. This allows monitoring of the current status of all claims, and summaries of patterns in claims occurence, which may be helpful in reducing claims, awards, and insurance costs.

Labor bargaining tool. Spreadsheets can be used to estimate the cost of labor contract proposals. The spreadsheets can be set up in advance to calculate the cost of contract provisions such as wage rate increases, cost of living, paid time off, and fringe benefits. During negotiations, proposed terms can be included in the spreadsheet to provide a rapid estimate of their cost over the life of the contract.

Another benefit of microcomputers during negotiations arises when personnel and scheduling information is maintained on the computer. This data can be retrieved and summarized quickly in order to determine, for example, how many employees might be affected by a certain change, how many runs meet certain conditions, or how paid time off is currently used.

Report transmission. Reports sent to state and local agencies can be transmitted automatically if the receiving agency has the appropriate equipment. This requires a communications program and a modem, which produces a signal that can be sent over telephone lines. Reports would be prepared in the format required by the receiving agency. This application would allow reports to be prepared on the microcomputer and sent without completing paper forms.

Human Service Applications

Human service and demand responsive transportation operations that deal with individual clients and complex billing procedures have very large information loads for the size of the operation. At the same time they usually have limited staff and very low budgets. These conditions make the ability of microcomputers to manage this information particularly valuable to them.

The complexity of the system can range from separate handling of the registration, booking, and billing functions to an integrated system in which these three functions are interconnected. This offers the agency a range of approaches to the problem depending on the size of their operation and their computer experience and resources.

The Urban Mass Transportation Administration is sponsoring the distribution of a human services record-keeping system using a database management program. This approach allows each property to work with a local programmer in adapting the program to their own needs.

Client registration. Maintaining records on each client, including personal data, sponsoring or certifying agency, and special transportation needs is one application of database management for human service operators. This information can be summarized to produce lists of clients by sponsoring agency, by handicap, and by other characteristics. Mailing lists can also be produced.

In an integrated system, the information on home location, telephone number, and transportation needs can be used in booking trips by each client. The sponsoring agency can be automatically looked up by a billing and reporting system.

Booking and scheduling. A database manager can be used to help schedule demand responsive trips by creating a list of trips to be carried by each vehicle. Data normally entered for each trip would include client, origin, destination, transportation needs, time, sponsor, and possibly trip purpose. This list of trips allows revisions to be made as necessary, provides a schedule for vehicle operators, and can be summarized by sponsor for billing purposes.

In an integrated system, the information on the individual client required for booking, such as home address, transportation needs, and sponsor, could be drawn directly from the client file. The list of trips made by sponsor and client would be sent to the billing module to provide the basis for billing.

Billing. The third data management process for human service transportation providers is billing. Database management can help to provide a complete record of trips sponsored by each agency, and to calculate the billed cost of those trips. Data on each sponsoring agency, including address and billing rate, can be combined with monthly data on the actual trips carried. In an integrated system much of the information required for billing, including client information and trip data, would be drawn from the client registration and booking files.

Software Requirements

The list of applications identified as promising to implement in the agency can be used to give an approximate picture of what types of programs the agency will ultimately need. Figure 3.3 summarizes the types of programs used for each of the applications described above. A typical mix of software, in which generic commercial programs complement a selection of transit specific application programs, is described below.

Generic Software

It is safe to say that every microcomputer system should include the three main types of generic programs: a spreadsheet, a database manager, and a word processor. Each of these types of program has a multitude of uses in the transit agency. They are easy to work with,

Area	Task	Generic Software					Application Software	
		Spread-sheet	Word process	Data-base	Commun-ications	Stat-istics	Business Package	Transit Package
Finance	Budget development	*						
	Deficit allocation	*						
	Cash management	*						
	Fare revenue	*						
	Physical inventory			*				
	Monthly reports	*						
	General ledger						1	
	Accounts payable						1	
	Accounts receivable						1	
	Payroll						1	
Operations	Operating docs	*	*					
	Bus stop inventory			*				
	Scheduling	*						*
	Timekeeping							
Maintenance	Tire inventory			*				2
	Oil analysis	*						
	Ad management			*				
	Parts inventory			*				2
	Veh histories			*				2
	Mtce schedule			*				2
	Daily servicing			*				2
	Purchasing			*				2
Planning	Rev and ridership	*						
	Service allocation	*						
	Trip ridership	*						
	Route profitability	*						
	Survey processing					*		
Administration	Document preparation		*					
	Personnel admin			*				
	Operator records			*				
	Pass/token admin			*				
	Accident analysis			*				
	Claims tracking			*				
	Labor bargaining	*						
	Report transmission				*			
Human service	Client registration			*				3
	Booking/scheduling			*				3
	Reporting/billing			*				3

Application Systems: 1-Accounting 2-Maintenance 3-Human Service

FIGURE 3.3 Software Requirements for Transit Applications

and allow new applications to be developed with a minimum of specialized training and time. Their cost is low in relation to their usefulness.

Graphics is often included as part of a spreadsheet package. If not, it should be purchased separately, to work with the spreadsheet. Graphical illustration of spreadsheet data greatly increases their usefulness as a communications tool.

Other generic software is less versatile than the packages mentioned above, and should be purchased only if required for a specific application. A statistics package, for example, is only required if survey data is to be analyzed by agency staff. Likewise communications programs may be very valuable if data is to be transmitted directly by telephone to a remote garage or to state agencies.

Transit Application Software

Unlike generic programs, which do not have to be selected to fit the particular needs of an agency, application software is selected in response to identified needs. The particular set of programs used by an agency should reflect that agency's selection of microcomputer applications.

In some cases, application programs should be treated as a set, with each program designed to be used with the others. Three examples of this are indicated in Figure 3.3: accounting, maintenance management, and human services software. In the case of accounting, for example, general ledger, accounts receivable, accounts payable, and payroll should be integrated with each other.

Hardware Requirements

It is important to consider the amount and pieces of computer equipment that you are likely to need in the future. This provides a framework within which to select the initial purchases. It is also helpful in identifying what additional information will be needed in making future decisions about the growth of the system. (The Hardware Handbook describes the various components of a microcomputer system.)

Five issues that affect the overall shape of the computer system are discussed in this section:

1. The number and location of workstations.

2. The amount and use of storage.

3. Requirements of specific applications.

4. The amount and type of coordination between users.

5. Future needs for flexibility.

Number and Location of Workstations

A good idea of the scale of the future computer system can be obtained by identifying how many workstations will be required. Each workstation is a desk equipped so that staff can use the computer, and has at least a keyboard and a monitor screen.

Based on the applications that you expect to be using, list the staff members who will be using the computer, and what they will be doing with it. Most staff members' computer use will fall into one of four categories: data entry, reference, development, or analysis. Estimate roughly how much time you might expect each one to be using it (e.g., 2 hours daily, or 10 hours once a month). You may have very little feel for how much time will be involved, but an intelligent guess is better than not considering the problem at all.

This information can be used to make a reasonable estimate of how many microcomputers will be needed. Adding up the various staff users' times will give the number of hours the computers will be used during a busy day of the month. In general the maximum reasonable use of the computers is about 70% of the time, or 5.5 hours of an 8-hour day. If they get busier than this, and it becomes necessary to sign up in advance for a time to use them, staff will be discouraged from making the most of the tool.

The workstations should be located where they will be conveniently accessible to all users. Very few users make constant enough use of the computer that they should have a workstation in their office or at their desk. A workstation in someone's office effectively discourages other people from using it, and makes them very self-conscious. Especially during the early introduction of the microcomputer it is important that people have ready access to the machine and feel as comfortable as possible about using it and exploring it.

There is some advantage to having several workstations grouped together. Particularly if they may share some equipment, for example if they will be hooked up to the same printer, a centralized location makes this much easier to arrange. This arrangement also allows the miscellaneous bits and pieces that go with the system to be located in one place. Program manuals, reference materials, paper, and diskettes can be stored in one location so everyone will always know where they should be. Concentrating the equipment may also make it easier to secure the machines. If they are all in one room all that is required is to lock the door. The advantages of concentrating the microcomputer equipment must be traded off against the convenience to the users of having workstations at nearby locations around the office.

Additional equipment may be required if the agency has facilities at several locations, and if the microcomputers will be used at several facilities.

Amount of Storage

In general, any fair-sized application that is primarily a database management problem will require a hard disk. Of the applications listed above, maintenance management, inventory, statistical survey analysis, and human service applications will require a hard disk for most agencies.

The use of a hard disk can be a constraint on microcomputer systems. The hard disk is permanently attached to a particular computer. Each application that has data stored on a hard disk must be done on a computer with that hard disk attached. It is possible under certain circumstances to share a hard disk between several computers by using a network.

Requirements of Particular Applications

Some microcomputer applications in transit agencies require particular peripheral equipment to be attached to the computer. The two usual types of perpherals required by applications are printers, and modems. Figure 3.4 summarizes some usual hardware requirements.

Different applications may place conflicting requirements on the system's printers. For most day-to-day use a dot matrix printer is fast and provides desirable flexibility. This type of printer is required to produce graphs or to compress large tables onto standard sized pages. Letter quality print is required if the microcomputer will be used for word processing of correspondence, reports, or publicly distributed documents. Letter quality print can be produced either on a slow impact printer of the daisy wheel or thimble type, or by purchasing a more expensive dot matrix or laser printer.

A reasonable solution to this problem in a system with several work stations is to have one of each type of printer. Printers usually receive heavy use and contain many moving parts, so they are more likely to fail than other components of the computer system. For this reason it is a good idea to have more than one printer as a back-up.

Modems are required for those situations where data is transferred between computers over telephone lines. There are two situations where this could be valuable. If the agency has several remote facilities, each one with computer, and data or programs must be shared between them, this material can be transferred by modem and telephone. A second use would be for sending data to another agency using a computer, such as a city accounting office, state transit office or a payroll processing bureau.

Area	Task	Graphics Printer	Letter Printer	Modem	Large Ram	Hard Disk
Finance	Budget development	*				
	Deficit allocation					
	Cash management					
	Fare revenue					
	Physical inventory					
	Monthly reports					
	General ledger					*
	Accounts payable					*
	Accounts receivable					*
	Payroll					*
Operations	Operating docs	*				
	Bus stop inventory					
	Scheduling	*				*
	Timekeeping					
Maintenance	Tire inventory					
	Oil analysis	*				
	Ad management					
	Parts inventory					*
	Veh histories					*
	Mtce schedule					*
	Daily servicing					*
	Purchasing					
Planning	Rev and ridership	*				
	Service allocation					
	Trip ridership	*				
	Route profitability					
	Survey processing				*	*
Administration	Document preparation		*			
	Personnel admin					
	Operator records					
	Pass/token admin					
	Accident analysis					
	Claims tracking					
	Labor bargaining					
	Report transmission			*		
Human service	Client registration					*
	Booking/scheduling					*
	Reporting/billing					*

(Columns Graphics Printer through Hard Disk are printed under the spanning header "Hardware Needs".)

FIGURE 3.4 Hardware Requirements for Transit Applications

Coordination Between Workstations

Information is constantly being passed between people in the management of a transit operation. When functions are automated this information exchange, which occured informally before, must become more structured. Many microcomputer applications are related to others through sharing or exchange of information or data.

This coordination between users and applications can be handled in several ways. The most straightforward is to store information on floppy diskettes, which can be passed by hand from one user to another. This method is easy to implement, and requires no special technical arrangements of programs or equipment.

A second system for coordinating applications is to make sure that all applications that share certain data are performed on the same computer equipped with a hard disk. This allows data to be stored on the computer's hard disk, and used by different users and applications on the same machine. This strategy requires some forethought to set up.

Training and Support Requirements

Selecting and purchasing the programs and hardware is not the most challenging aspect of microcomputer implementation. Instead the success of microcomputer applications is determined by the preparation and attitudes of staff using them, and by the way in which they are integrated in the organization. Aspects of this include training, support, and procedures.

Training

It is difficult to overestimate the importance of training in contributing to successful microcomputer use. Training includes both formal classroom and workshop work, and informal time spent by an employee exploring the capabilities of the system. Portions of the time spent developing early applications in-house will actually contribute to the training of staff.

Different employees have different training requirements. Some will be naturally interested in the machine. For these people it may be sufficient to make informational materials, such as operating manuals, tutorials, or periodicals available to them. They will actively extract the information that is useful to them. More challenging are the employees who are not particularly interested in the technology, or who resist accepting it. Training of these people must be handled carefully to allow plenty of non-threatening opportunities to become familiar with the computer. Hands-on work is particularly important to these people because it demonstrates dramatically what the computer does and builds their confidence.

Training is not simply a one-time activity associated with introducing the computer. Formal training must be complemented by informal opportunities to apply the material. As confidence and experience with introductory concepts is obtained, more material can be introduced through formal training.

A variety of training resources are available to suit various people's needs. Intensive transit-specific courses are offered by various institutions and provide an unusual opportunity to be immersed in the subject for several days without the usual competing pressures of daily agency activity. Numerous introductory and specialized courses are offered in most locations by adult education programs, community colleges, and computer stores. These may provide a general introduction to computer use that must be complemented by experimentation with transit applications developed independently or borrowed from peers. Individuals with expertise are also a source of training. A trainer can be hired to provide structured instruction to a small group of agency staff. Alternatively, such a person, particularly when on the agency staff, can provide informal personalized training on an ad hoc one-on-one basis.

Training needs must be addressed deliberately. Although some people will pick up a great deal by experimenting informally with a computer on their own, pressures from ongoing operating activities tend to prevent staff from having the opportunity to spend sufficient time experimenting, particularly if they are not very receptive to the microcomputer to start with. For this reason formal outside training must be complemented by specific opportunities to make use of the computer in the office. One way of providing this is to designate a particular simple application to develop or use. This not only legitimizes time spent working with the microcomputer, but also establishes a specific objective toward which to work.

To make the most of a microcomputer system, each staff member involved in a microcomputer application must be encouraged to become an active user of the system. This requires careful attention to each user's individual needs. Investment in the programs and equipment must be complemented by adequate investment in the staff that will use it.

Ongoing Support

Once staff have implemented some initial applications on the microcomputer additional support is required to continue to progress and take advantage of the capabilities of the system. This, too, can be provided in several ways.

Very often one staff member becomes a "power-user" by taking the initiative to independently learn about the system beyond his or her immediate needs. This individual usually informally provides support to fellow staff members by being on call to answer questions, troubleshoot, and make suggestions. The support provided by such an arrangement is very valuable, because in can be responsive and non-threatening. On the other hand it can become very time-consuming to the person in question.

This should be formally recognized in order that the organization can take advantage of the in-house expertise without overloading the support person with too many responsibilities.

Resources can be developed outside the agency, too. A local individual can be retained on a formal basis to provide support as needed. Informally, contacts with other microcomputer users can provide a source of support. It is helpful to identify other people who are using the same programs or equipment that you are, either in your community or in the transit industry. They may have had to address some of the same problems that you have, and are usually pleased to share their knowledge.

Periodicals and books may be another source of support. Books have been written concerning the use of the more popular microcomputer programs. These may include practical tips and ideas not included in the documentation that comes with the program. Periodicals concerned with one specific type of microcomputer often include features on using the computer for various tasks, including detailed instructions. Only fairly motivated users are likely to follow up this information.

Needs Assessment Preparation

The findings on the analysis performed so far should be summarized in a document. This document should present an overall vision of what the role of microcomputers in the agency could ultimately be. A sample outline is shown in Figure 3.5. The report can serve four purposes:

1. Bring together the findings of the needs assessment, and help the staff member performing the needs assessment to organize and complete his or her thinking.
2. Provide a focus of internal discussion about the new system. Inform staff about the system and their involvement in it. Provide a basis for programming and planning the implementation of the system.
3. Provide a document for discussion with outside bodies, such as the board, concerning the costs and benefits of the system.
4. Serve as a starting point for future development of the system, including modification and refinement of the original plan as necessary.

It should be recognized that the needs assessment document is prepared with limited understanding of how computers work and what they can do. Furthermore the technology is still changing rapidly, and new developments may affect the feasibility of various transit applications. The plan should provide a basis for initial decisions. It can be revised as staff gains additional understanding of the technology and its potential role in the transit agency.

Needs Assessment Example Outline

I. Microcomputer applications at GWTA
    A. Task one
        1. Benefits
            a. (Time savings)
            b. (Flexibility)
            c. (Additional reports)
        2. Software requirements (general)
        3. Hardware requirements (general)
        4. Staff involved
        5. Implementation
    B. Task two
        1.
        2.
        etc.

II. Summary of software required
    A. Generic software
        1. Spreadsheet
        2. Word Processor
        3. Database manager
        4. (Statistical package)
        5. (Communications package)
    B. (Application packages)
        1. (Accounting)
        2. (Maintenance management)
        3. (Scheduling and runcutting)
        4. (Human service records)

III. Summary of hardware required
    A. Number and location of workstations
    B. Peripheral equipment
        1. Hard disk
        2. Printers
    C. (Coordination)
        1. (Communications, modem)
        2. (Network)

IV. Staffing and training
    A. Proposed staff responsibilities
    B. Training requirements
        1. Structured training courses
        2. Informal development needs
    C. Support requirements
        1. In-house support person
        2. External support resources
        3. Publications and periodicals
        4. Transit peers and user groups

() Indicates optional elements to be included of relevent to the agency.

FIGURE 3.5 Sample Needs Assessment Outline

CHAPTER FOUR

PHASE 2: INITIAL IMPLEMENTATION

Having established in Phase 1 a goal for the ultimate role of the computer system in the agency, Phase 2 addresses the initial steps to be taken in order to arrive at that (or a revised) goal in the most efficient and positive way possible. This requires selecting initial activities that are relatively easy to implement, rewarding, and consistent with the plan for further developments in the future.

The initial implementation should accomplish the following:

1. Provide selected agency staff with sufficient familiarity with the microcomputers that they are able to contribute to planning and developing additional applications, and so that they can discuss options critically with salespeople and consultants.

2. Generate visible benefits for the organization that will encourage staff interest in and enthusiasm for the microcomputer as a tool, and overcome staff resistence.

3. Install in the agency a basic microcomputer system that can be incorporated in a more extensive system in the future.

Phase 2 includes five steps:

1. Choosing initial applications.
2. Choosing initial software.
3. Choosing initial hardware.
4. Procurement.
5. Implementation.

Of these, the two most crucial to the success of the project are the choice of applications to be implemented (step 1), and the way they are implemented (step 5).

Choosing Initial Applications

The initial choice of applications to be implemented is actually a choice of strategy for introducing microcomputers. The characteristics that should be considered in selecting applications include:

1. Difficulty of application development.
2. Anticipated benefits from the application.
3. Ease of implementing the application.

Difficulty of Development

An important factor in selecting applications is the ease with which they can be developed. This includes several different factors. First, applications that make use of the generic commercial software packages are often easier to introduce than custom applications or transit packages. These programs are designed to be used by people with limited computer experience, and are "user friendly" or supportive of new users. Menus offer a choice of actions, prompts indicate the information the user is supposed to input, and errors by the user are anticipated so that a helpful message is displayed without serious damage being caused.

Second, an application of a relatively simple task is easier to develop than a more complex one. The staff member involved must be very comfortable with the mechanics of performing the task manually. Applications that involve interrelationships between different users, data, or applications should be avoided. Each initial application should be the responsibility of only one person. Data requirements should be simple and met by manual data input.

Initial applications should be developed by in-house staff without requiring the services of a consultant to allow staff to develop confidence and a vocabulary of skills. The applications may be modified from on modelled on an application in use at another agency, to reduce the amount of development required. The basic skills developed initially will support a more effective working relationship with outside programmers or consultants for developing later, more complex applications.

Figure 4.1 shows the applications described in Chapter 3 sorted by the degree of difficulty of application development. The following levels of difficulty are used:

1. The application can be developed in-house by agency staff with introductory training in the use of generic programs. The application can be based on current manual procedures or modified from a microcomputer application in another agency. The task is a stand-alone exercise.

Area	Task	Spread-sheet	Word Process	Data-base	Commun-ications	Stat-istics	Business Package	Transit Package	Difficulty
Administration	Document preparation		*						1
Finance	Deficit Allocation	*							1
Finance	Monthly reports	*							1
Finance	Budget development	*							1
Finance	Fare revenue	*							1
Finance	Cash Management	*							1
Maintenance	Bus Assignment	*							1
Maintenance	Oil analysis	*							1
Operations	Bus stop inventory			*					1
Operations	Scheduling	*							1
Operations	Operating docs	*	*						1
Planning	Trip ridership	*							1
Planning	Service allocation	*							1
Planning	Rev and ridership	*							1
Planning	Route profitability	*							1
Administration	Personnel admin			*					2
Administration	Claims tracking			*					2
Administration	Accident analysis			*					2
Administration	Charter admin	*		*					2
Administration	Grant administration	*							2
Administration	Pass/token admin			*					2
Administration	Operator records			*					2
Finance	Physical inventory			*					2
Finance	Interface w. city				*				2
Maintenance	Parts Inventory			*					2
Maintenance	Tire Inventory			*				2	2
Operations	Bid management	*							2
Planning	Survey processing					*			2
Human Services	Booking /scheduling			*				3	3
Human Services	Reporting/billing			*				3	3
Human Services	Client registration			*				3	3
Finance	Accounts receivable						1		3
Finance	Payroll						1		3
Finance	Accounts payable						1		3
Finance	Monthly reports						1		3
Finance	General ledger						1		3
Maintenance	Purchasing			*				2	3
Maintenance	Parts Inventory							2	3
Maintenance	Daily servicing			*				2	3
Maintenance	Mtce Schedule			*				2	3
Maintenance	Veh Histories			*				2	3
Operations	Timekeeping								3
Operations	Scheduling							*	3

FIGURE 4.1 Applications by Ease of Implementation

2. The application can be developed in-house by a staff member with microcomputer experience, or with the assistance of a local programmer. A moderate amount of time is required to design and develop the application or to modify it from that in use at another agency.

3. The application requires the services of a programmer/consultant. The application is complex and involves time-consuming development, or modification of a purchased application program.

The difficulty ratings applied here are a generalization and may vary depending on the procedures at each agency or the particular approach taken to using the computer for the given task.

Anticipated Benefits

It is important to select applications for early implementation that have clearly recognizable benefits. This will help to ensure that a positive outcome counteracts the discouraging aspects of learning to use the microcomputer, and that staff members will be encouraged to become involved with additional applications of the technology. Expected benefits should have been listed as part of the automation plan. Benefits should not be exaggerated, or staff will become disappointed in results of the application.

Specific improvements should be identified. If a manual procedure already works well, and it is not clear what improvement would be produced by a microcomputer application, it should probably not be implemented. It may not result in benefits sufficient to make the effort of developing a new application worthwhile.

Ease of Implementation

Although the application itself may not be difficult to develop, other issues may make an application difficult to set up, and unsuitable for early implementation. An application that is part of a disorganized process will probably face unnecessary difficulties in implementation. Not only will the technical aspects of the problem have to be addressed, but new procedures may have to be set up, new codes or numbering systems introduced, and other organizational changes introduced. This may prevent the success of the application.

A major factor in the success of early applications is the level of interest and capability of the staff members involved. Early users of the microcomputer should be individuals with an active interest in the microcomputer who will later be able to communicate their experience and share their knowledge with other users in the agency. Staff members who are not confident about exploring the technology may become easily discouraged unless special measures are taken to provide support for them.

The amount of effort required to set up the application can also create an implementation problem. For example, a parts inventory system may require information on several thousand different parts to be input to the system before it becomes useful. This could have the effect of seriously delaying the application, or souring the staff member who gets stuck with the job of inputting all that information. Hiring temporary help could be worthwhile for this type of task.

Choosing Initial Software

In general, software required for initial applications should be limited to general purpose commercial programs such as spreadsheets, simple database managers, and word processors. These programs have numerous applications in any transit agency. At the same time they are sufficiently easy to use that they are excellent tools for introducing microcomputers to new users. These programs have two characteristics that make it easy to select them as initial software purchases.

First, these types of programs have been in widespread use for several years. As a result there are many competing programs available. This may make choosing a program confusing; however, it also means that there are low cost, but effective, products available of each type. These inexpensive products can be very helpful as experimental purchases to allow agency staff to become familiar with a general type of software. This allows them to understand clearly what the use of a type of program is and what their specific requirements might be. One source of such programs is Freeware or Shareware programs that can be freely copied and distributed. The cost of these programs is low enough that they can be considered disposable learning tools, if they are found to be too limited for the agency's needs.

Second, there are now a number of mature programs of each type (particularly spreadsheets and word processors). These programs incorporate the best features of the various pioneering programs that preceded them. Some of these programs are in widespread use, so they are supported by a broad base of users in most communities. This provides a valuable resource to new users. These programs provide a limited selection of powerful commercial products from which to choose.

More detail about choosing specific generic programs is included in the Software Handbook.

Choosing Initial Hardware

The main objective in choosing initial hardware is to get a basic, reliable system that leaves your options open for future development. Starting with a basic microcomputer system allows you to focus on products that have been widely used and tested. Specific enhancements or more exotic equipment can be added later when you have gained working experience with the computer, have identified your specific needs, and can critically evaluate the range of products available.

The components that make up a basic computer system are listed in Figure 4.2. This system would be adequate to perform any of the spreadsheet and word processing applications listed in Figure 4.1, as well as many of the simpler database applications. The Hardware Handbook describes each system element in more detail.

1. Computer containing:
   - keyboard
   - 256 K RAM minimum
   - (Color graphics or high resolution graphics adapter if graphics are to be used)
   - 2 disk drives or one floppy disk and one hard disk
2. Monitor (Monochrome, but should display graphics)
3. Printer (dot matrix and/or letter quality)
4. Cables

FIGURE 4.2 Initial Hardware Shopping List

The easiest way to improve the likelihood of getting a reliable system is to select equipment and components that have been delivered for six or more months. A system selected in this way may not be on the cutting edge of the technology, but it is likely to fill your needs reliably. The most accurate source of information on equipment is a user with experience. Advertising and information provided by retail distributors on new products often makes exaggerated claims about the product, and fails to mention drawbacks such as incompatibility with certain programs or other equipment. In addition, retailers may underestimate the amount of time until they can deliver the product, and may not have discovered bugs in the product.

Another issue in choosing hardware is the stability of the supplier. The flexibility available for developing the system in the future depends on the same or compatible computers continuing to be available. In addition, many accessories are useful for adding to the convenience or power of the system. These are often manufactured by specialized companies to be used with the computers most widely in use. If a computer is abandoned by the manufacturer, or the manufacturer goes out of business, the supply of complementary accessories may be small and unreliable.

Procurement

Using an incremental approach to system development gives added flexibility to hardware selection because the initial procurement can usually be done without a formal bid process. For most small to medium-sized transit systems, one or two computers should be ample for initial applications. With the cost of a computer under $5000, the initial investment can be made without needing to receive competitive bids. This simplifies the process, allows you to shop around at local outlets, compare products, and identify a distributor with whom you feel comfortable.

The process of procurement without competitive bids should involve both:

1. Conversations and price quotes from computer distributors.
2. Discussions with peers and microcomputer users in the transit industry.

Starting with a basic microcomputer system allows you to focus on products familiar to and readily available from most computer outlets.

Visits to local computer distributors can be a confusing experience. It seems that each distributor has a collection of products to promote, and comparison between different suppliers' products may be difficult. Store staff may not be very knowledgeable about particular products, or willing to take the time to explain them. It is important to ask as many questions as you need to feel comfortable with their explanation. Feel free to ask for a particular product to be demonstrated; this will give you a much better understanding of how it could fit into your agency's operation.

A perspective on available products can be obtained by discussing them with microcomputer users in the industry, or by referring to the many computer periodicals available. Industry peers can share their experiences with you and discuss the technology in terms of your common background. This is particularly useful to clarify what value various attributes of the computer have had to them. The most useful periodical articles are those that compare several products of the same type. This gives an idea what sorts of things to look for in comparing products.

There is little advantage in purchasing all your anticipated software needs together. Commercial programs can be readily bought from mail order houses at reduced cost as the agency is ready for them. If you have problems with software, you are likely to get help from the publisher or from other users, so having a good relationship with a local dealer is not essential. This means that you can start with inexpensive programs of each type, and graduate to more sophisticated and expensive packages as confidence develops.

Implementation

Implementation of the microcomputer system is a key step that often is taken for granted. The enthusiasm and momentum generated during the design and procurement of the initial system must be maintained in introducing it to the organization. Active attention to implementation will help to ensure that the new equipment is used productively and evolves into a valuable tool for the agency.

Specific, reasonable objectives should be established for each staff member. If the initial applications have been carefully selected they may serve as objectives, or it may be desirable to further break the applications into subunits that appear more achievable to agency staff. Realistic worthwhile objectives will give staff members satisfaction and maintain a high level of enthusiasm for the project.

Plans for training, identified in the needs assessment, should be set in motion. Training should be treated as an essential investment in the system. All users of the system should have an opportunity to receive training appropriate to their needs.

Support mechanisms should be put in place to help staff involved in early applications. Contacts with skilled users should be developed, reference materials obtained as required, and worthwhile periodicals selected. These resources should be made available to system users for reference or browsing.

The initial implementations should produce useful applications for the agency. They should also result in valuable input for further development of the system: experience and additional research.

Experience

The experience that agency staff gains during the initial implementation phase increases the amount of flexibility available in developing the system further. Once the basic skills have been mastered staff will be able to learn and adopt new techniques increasingly quickly. As technical aspects of the system become more familiar, energy can be diverted to developing applications for more complex tasks.

Users of the system will also develop judgement about the strengths and weaknesses of application software they are using. Limitations of initial applications will be identified. Users will define improvements they would like for each application. This experience will allow staff to effectively specify the characteristics of new applications to be added as the system develops further.

Research

Staff using the microcomputer during the initial implementation phase will develop skills and the vocabulary to benefit from outside sources of information. Information obtained from experienced peers, suppliers, and technical sources will fit in the context of knowledge provided by initial applications.

These resources can be used to gather additional information about applications being considered for future development. Suppliers of programs for these applications can supply specific information on their product. Experiences of other agencies with each application suggest promising directions and potential problems. This input will become increasingly meaningful as more experience with microcomputers accumulates, providing a solid foundation for Phase 3.

CHAPTER FIVE

PHASE 3: ADDITIONAL APPLICATIONS

Some time after implementing the initial computer system, needs for adding applications or extending the capabilities of the system will become evident. One of the great advantages of microcomputer systems is the ease with which they can be enhanced and expanded. This should be done within the framework provided by the automation plan to ensure that a consistent direction for the system is maintained.

Updating the Plan

The automation plan developed in Phase 1 provides a basis for expanding the system as the need arises. In some cases, the ideas incorporated in the plan will still be appropriate, and the plan can be used as it stands for enhancing the system. More often, additional information gained during the early experiences with the computer will help to clarify priorities and possible applications that were unclear when the plan was developed. Organizational constraints, such as varying personal levels of interest in the possibilities offered by microcomputers, may also affect the strategy for system expansion.

Development of the microcomputer system beyond the initial system may be motivated by two immediate concerns:

1. Capacity constraints imposed on existing uses by the present system, such as insufficient memory, not enough machines to meet the existing demand, or insufficient mass storage.

2. Additional applications to be developed, either as included in the automation plan, or as agency needs indicate. These may involve acquiring or developing application software, as well as adding hardware to the system.

Capacity Constraints

If Phase 2 has been successful in generating staff interest in uses of the microcomputers, the demand for them may be placing pressure on the facilities that were first acquired. This problem can usually be resolved by purchasing additional hardware for the system.

Number of machines. The most common constraint is that demand for time using the machines exceeds the supply. When this starts occuring, a brief review of the applications in use should be made. It may be that some application is taking more time than it justifies. Word processing, for example, can easily consume large amounts of microcomputer time, when some short documents, (letters and memos) could be prepared equally well on a typewriter. If the use of the existing facilities is worthwhile, it may be desirable to expand the system by purchasing an additional machine.

Random access memory. Occasionally the amount of random access memory in the machine may cause problems. This is most likely to be the case if applications developed in the first phase deal with management or statistical analysis of large databases. Additional memory can be purchased and installed easily as required, up to the limit imposed by the microcomputer. The amount of memory that can actually be used may also be limited by the specific programs in use. For example, though the microcomputer may have 512K of random access memory, a particular program may only be able to use 256 K. Therefore, that program may not be suitable for the agency's applications.

Mass storage. A third way in which the system's capacity may be stretched is in the amount of mass storage available in the form of floppy or hard disks. Depending on the type of applications in use and the resulting data files, additional storage may be provided by simply using more floppy disks or by adding a hard disk. If large amounts of data are being stored, careful management and procedures may be required to ensure that data is maintained while it is useful, and is removed from active storage when it becomes obsolete. Out-of-date information should be archived periodically onto floppy diskettes, where it will be available if needed while not consuming accessible hard disk space.

Speed. Although microcomputers and programs vary in the speed with which they perform tasks, often even slow systems in computer terms may be faster than the practical needs of the human user. If the slowness of the system is an inconvenience to the user, it may be worth making changes to speed it up. Depending on the particular application, various responses can be made to this problem. Database and statistical packages vary in the speed with which they perform various functions. If a particular program is too slow for your applications, it may be worthwhile to purchase a faster program. Sometimes the speed of the program can be affected by the amount of memory available in the microcomputer; adding memory may speed up the task. Statistical or computational problems may simply be executed slowly by the microcomputer. Enhancing the microcomputer with a faster chip for these types of applications and making the appropriate changes to the software may be required.

Additional equipment. As agency staff gain experience with the system they may identify other desirable enhancements to the system. Specific equipment such as additional or more versatile printers may be indicated. Communications equipment may be required for certain applications or users. In general, it is better to identify equipment requirements in response to specific functional needs than to purchase too much at early stages when the needs are not known.

Adding Applications

The true expansion of the computer system in the organization occurs when additional applications are developed for the microcomputer. Each new application must be prepared carefully to ensure that it does the job and is integrated with other applications and organizational procedures.

Development of new applications for the system should be done within the context of the automation plan. This plan provides an overall perspective and strategy for development of the system, and helps keep track of the many factors affecting the development and use of the system. The plan should not be viewed as a constraint or fixed procedure, but as a foundation for modifications and additions.

The applications identified in the automation plan should be reviewed when changes to the system are being considered. The portion of the plan that discusses potential applications should be revised to incorporate information and experience obtained through the initial implementation phase. Staff will be better able to visualize how each application might work, what the benefits are likely to be, and what the issues and obstacles to development are. These changes may result in new priorities among the applications described in the plan.

New applications are likely to be identified as agency staff become familiar with the microcomputers and see how they might be applied to various agency tasks. New ideas should be reviewed using the same structure as was used for the initial applications:

- Task analysis
- Procedure
- Potential improvements
- Information flows
- Staff issues

Application Development Strategies

Many applications can be developed in a range of different styles using different procedures. Alternatives that may be available include:

1. Applications developed by staff in-house using generic packages.

2. Purchased application packages modified by the consultant supplier.

3. Applications developed with generic software or modified from existing programs by local programmers.

4. Custom applications developed to specification by a programmer or consultant.

For example, microcomputers are used to help inventory management in a number of ways. A file manager can be set up by agency staff to maintain the current status of each part, without linking parts usage to work orders or supporting purchasing. Application packages are available for inventory management, and may include purchasing, parts tracking, and usage analysis modules. Similar capabilities could be obtained by having a programmer or consultant develop a custom program for the agency. Each of these approaches has different costs, benefits, and pitfalls, which are summarized in the following sections.

In-House Development

Many agencies have developed numerous microcomputer applications in-house. The vast majority of these are uses of the multi-purpose generic software packages that are designed to provide versatility. Other agencies have benefitted by the skills of a staff member with programming experience who has written programs in BASIC or another language to perform particular tasks.

Advantages. Applications developed by in-house staff provide several advantages to the agency:

1. Development of staff expertise with the computer.
2. Ability to modify or tailor the application in-house.

The ability of the agency to make the most of the microcomputer for day-to-day applications depends partly on the familiarity of the staff with its use. Many of the most productive uses of the microcomputer require the user to be comfortable with a range of the computer's powers that can be marshalled to address a particular problem. This does not require staff to become programmers, but to know how to use several of the most usual packages. Development of simple applications provides a natural opportunity to cultivate these skills.

An application that has been developed in-house is within control of the staff who will be using it. Staff will be familiar with what the application actually does. This will allow them to modify it by changing report formats, and making use of the full potential of the generic package for their task.

Disadvantages. There are also several disadvantages to developing an application in-house:

1. Use of staff time.
2. Creation of disorganized, undocumented applications.

Application development can be a time-consuming activity. The complexity of the task depends on both the complexity of the application and the software used to develop the solution. One of the advantages of generic packages is that they reduce the time required to develop new applications. Programming with BASIC or a comparable language, on the other hand, can be very time-consuming and frustrating. The time spent developing new applications can be worthwhile if it enhances a staff member's skills, and if those skills are useful to the agency. Most agencies do not need a skilled programmer in BASIC on staff.

Documentation of applications developed in-house often gets little attention. When the developer has got the application working it usually goes into immediate use without preparation of supporting documentation or instructions. This is fine as long as it is used by the developer, but the application may be useless to anyone else. This problem can be overcome if the agency has standards for documentation, provides examples of what is required, and enforces them.

Requirements. The success with which applications can be developed in-house can be increased by providing for the following functions:

1. Staff preparation, functional requirements.
2. Documentation.
3. Coordination (in large agency).

No matter how any application is developed or procured, the first requirement is an evaluation of the procedures involved in the application, and description of connections between the application and existing procedures. There is a tendency to overlook this step when developing an application in-house as staff members may feel that they understand how the procedure is done. Making procedures and application requirements explicit before starting provides an opportunity to think through the opportunities posed by automation, the changes that it will introduce, and the structure of the application to fit the agency needs. This will save time and reduce problems later, during application development and implementation.

Coordination with other users and applications should also be considered in agencies with several or more microcomputer users. Overlapping uses of data should be coordinated. Staff members who work together on a particular task, including those who provide input data and those who use output reports, should contribute to setting requirements, both to incorporate their ideas, and to gain their support for the project.

Explicit standards for documenting applications should be developed. The developer of any application that will be used more than once should prepare documentation conforming to these standards. Documentation should include:

- What the application does.
- What data is required.
- What reports are produced.
- How to use it (step-by-step).
- General structure of the application, software used.
- List of variables, if relevent.
- Printout of the program, spreadsheet, etc.

Documentation can be kept where the system manager will be able to provide it to potential users of the application. A looseleaf binder with dividers, or a file cabinet located near the microcomputer work area are possible formats. Documentation should be kept up-to-date by incorporating modifications made by the user.

Purchased Application Package

Programs are available to perform some of the more uniform tasks in the transit operation or small business. Examples of these include accounting functions, inventory control, maintenance, and runcutting. These programs usually require a certain amount of preparation when they are first introduced. This is called installation, and includes:

1. Inputting data, such as account codes and titles or inventory codes and part names.

2. Specifying input formats so that input screens on the computer resemble paper forms use to record data in the agency.

3. Specifying report formats to produce reports containing the information required by the particular agency.

4. Making minor adjustments to the program to work with the specific equipment in use in the agency, in particular, monitors and printers.

Installation may be designed to be done by the user. These programs come with specific instructions on getting started and setting up the program for the agency. Other programs, usually the more specialized ones written by consultants, may require the assistance of the program's author to install them.

Advantages. If a program can be found that meets agency requirements for the application it can offer several advantages including:

1. Well-designed program for a specific task.
2. Moderate cost.

An off-the-shelf application program often can be a well-designed program for a particular task. These programs are the result of an intensive development effort by a specialist in the particular application. As a result, the purchaser may benefit from the developer's specialized knowledge incorporated in the program.

A second advantage of an application package is the moderate cost, compared to that of developing a custom program for the same purpose. The development cost of an application package can be shared by all agencies purchasing the product, thus reducing the cost to each.

Disadvantages. The major disadvantage of a package is that it is an inflexible product. An application package comes "as is". Unless modifications are made to the package, the purchasing organization must adapt to the package as it comes. Data input and report formats may not suit agency practice, or some desired functions may be missing.

Requirements. Issues to address in shopping for an application package include:

1. Functional requirements.
2. Shopping.
3. Documentation.
4. Support.

Functional requirements provide a benchmark against which to measure the performance of packages on the market. An initial set of functional requirements can be assembled before shopping begins. These may be modified later in response to the capabilities and limitations of products available.

For several transit functions there are a number of application packages on the market to compare. Information on the packages available can be obtained by responding to ads in the transit journals, from displays and materials available at American Public Transit Association (APTA) conferences, from the Software and Sourcebook published by the Department of Transportation, (see Appendix B for reference) or from peers. It is worthwhile to gather as complete information as possible about each candidate. In addition to promotional materials, the supplier should be able to provide samples of the menus used in the program, screens used for inputting data to the program, and sample reports produced by the program. Some suppliers provide demonstration diskettes to potential customers at a nominal charge.

These are helpful in allowing you to get a feel for how the program works, although they usually demonstrate limited aspects of the program, or handle a small amount of data.

Good documentation should be provided with any package. Good documentation has the following features:

1. An introductory tutorial or training session, presented step by step.
2. Well organized text in short sections with many clear subheadings.
3. Complete and clear explanations.
4. A complete index and table of contents.
5. Concise summaries of commands for reference.
6. A binder that lies open on the table.

Another consideration in purchasing a package is the level of support that can be expected in the future. The supplier's help may be required for training, answering questions, correcting errors or oversights (bugs), or any future modifications and enhancements. Suppliers of these programs may be small operations or individuals, whose future ability to provide these services is unknown. Previous clients of the potential supplier can provide useful information on this kind of question.

Modification of Package

A third strategy for developing an application is to have an existing package modified. An existing package may be selected to perform the major portions of an application. This package may be modified or enhanced by developing custom input and output formats, adding needed functions or changing limited portions of the program to fit the agency's needs.

An increasing number of basic products are available that can be tailored for the agency's specific needs. Among the most promising are prototype applications developed under UMTA sponsorship using commercial database management packages. These flexible packages are available or under development for parts inventory management, operator timekeeping, and demand responsive record-keeping, scheduling and billing. Some proprietary packages may also be suitable for modification.

Advantages. The flexibility provided by modifying an application allows three advantages to be combined:

1. Tailored product.
2. Moderate development time and cost.
3. Specialized basic application program.

The main reason for modifying a package is to obtain a product that more closely fits the agency's procedures than the original did. This provides an opportunity to tailor the resulting product to the needs of the agency. Links to other automated applications can be provided as required. The final product will be easily integrated in the agency's operating routines.

The cost of modifying a package should be moderate, compared with the expense of having a program custom-tailored. Alterations can be done by a local programmer with a moderate amount of knowledge about the application and some programming experience. The amount of programming required should be much less than writing the program from scratch. As a result both the hourly cost of the programmer and the amount of time required should be reasonable.

At the same time as flexibility is provided by modifying the program, the application retains the core of a specialized application program. Providing that the initial program was carefully developed by competent programmers familiar with the application the final product will benefit from the quality, expertise, and development resources incorporated in the initial program.

Disadvantages. The main disadvantage of having a program modified is the complication introduced by working with an outside programmer. This requires agency staff to be able to visualize and articulate the changes that are required and communicate them to the programmer. It requires the programmer to do a thorough job, complete with monitoring to check for bugs, and documentation of the changes. Working with programmers is discussed in more detail in a later section.

Requirements. Successful modification of an application package requires three components:

1. Functional requirements.
2. Appropriate package with source code.
3. Good management of programmer.

Unlike an off-the-shelf package, a modified application program allows the agency staff to specify certain aspects of the final product. While this offers opportunities to obtain a more appropriate product, it also places responsibility on agency staff to specify their requirements. Staff must become familiar with the format and capabilities of various programs for that application, in order to conceptuatize how a modified program could work with the agency's operation.

A key to developing an application by modifying existing software is the quality of the original program. The program must be substantially satisfactory for the application as it is, so that only marginal modifications are required. Fundamental problems with the software may result in major modifications that are more costly than having a custom program developed. The source code of any program to be modified must be available. The source code, which is the program text in the language it was originally written in, may not be available for some proprietary programs. Finally, the original program must be well structured and well documented to provide an organized starting point for the programmer.

The relationship between agency staff and a programmer/contractor is more complex than most agency-supplier relationships. The product being supplied is less tangible and more changeable than most procurements. Particular care must be taken to define the product required and the programmer's responsibilities. Some of the issues to be addressed include the project schedule, responsibility for installation and debugging, documentation requirements, training needs and future support.

Custom Package

Having a custom program developed is a major project, but which can produce a program well-fitted to the specific needs of the agency.

Advantages. The main reason for having a custom program developed is to obtain a product tailored to particular needs and constraints. This can be important if an application is unique or if an unusual analysis is used. In these situations no existing package may be appropriate for the task, or excessive modifications would be required to adapt them. Starting with a clean slate then provides the best opportunity to resolve the problem.

Disadvantages. Most of the disadvantages of having a custom program developed are related to the size of the project. Before beginning programming the application must be developed conceptionally both from the user's and the programmer's perspectives. This can give the project:

1. Long project time.
2. High cost.
3. Communications difficulties between agency and contractor.

An additional disadvantage may be:

4. An inflexible product.

Computer programming is notorious for taking longer than anticipated. The process of developing a new application involves several steps, many of which are more complicated than they initially appear to be. The application development process includes planning the function of the program, planning the structure of the program, writing the program, extensive testing and revision, and preparing documentation.

The amount of time required, combined with the skills needed from a programmer for application development result in the high cost of custom programming. The contractor should be somewhat familiar with the application in addition to having the technical skills to write a quality program. A more experienced individual is required than is needed to modify an existing program, resulting in higher hourly costs and possible expenses for travel. The cost of a custom developed program can be 10 times that of an off-the-shelf application. If no existing application is appropriate for the task, it may be worth the expense.

Custom application development also presents a challenge in managing the project. The agency-contractor agreement involves a complicated process and technical subject matter. Both agency staff and application developer may be unfamiliar with each other's specialities. Many peripheral issues are involved including the developer's relations with the end-user of the program, installation and testing procedures in a complex operating organization, and provision of support in the form of training and documentation. These complications make a carefully prepared contract important to the smooth progress of the project.

The negative side of the tailored nature of the custom-developed application may be limited program flexibility. If a program is designed to do a particular job in a specific way it may not be able to accommodate changes as the agency grows or procedures are revised. Modifications to a custom program may be more difficult than changes to a more generalized commercial program.

Requirements. If a custom program is the best solution to a problem the key to success is to establish a good framework for working with the supplier. This requires:

1. Clearly defining your functional requirements for the application.
2. Preparing specifications and a contract that describes all the contractor's responsibilities.

Both of these requirements are discussed in the sections that follow.

Incremental Application Development

One of the difficulties in approaching an application development problem is being able to imagine how the application could be handled on the microcomputer. In the same way as the system development process may be hampered by limited the knowledge of agency staff, the application development process is more difficult if staff do not have much exposure to ways of automating the application. Again, an incremental approach to application development can be helpful.

In general, useful knowledge can be gained by using fairly simple, low cost strategies first. This approach can quickly provide some benefits for certain portions of an application while clarifying the applications requirements for a more sophisticated and comprehensive program. For example, a simple spreadsheet application could provide immediate benefits in calculating monthly performance indicators while suggesting ways in which a more sophisticated application could be linked to revenue data, maintain records by operating division, or include a reporting function for summarizing data as required. Likewise inexpensive file or database managers can be used to maintain data for numerous transit applications and give staff ideas about the potential of a more expensive solution.

The same logic can be applied to the use of inexpensive off-the-shelf application software. Public domain programs or inexpensive application packages may not satisfy the agency's requirements for a particular application, but they can provide a valuable tool for exploring the use of automation and identifying characteristics needed in a more expensive off-the-shelf package or a modified or custom developed package.

Functional Specifications

Regardless of the development strategy used for new applications, it is important to develop a list of functional requirements before procurement or development begins. Functional requirements of the application describe how it should function from the user's point of view. Like the automation plan, functional requirements need not address the technical aspects of how the program accomplishes its task, except to identify technical constraints that may exist in fitting the application within the agency's microcomputer system. They should be complete and as specific as possible. Changes made later may be very costly and time consuming. In addition, they should convey any constraints that might affect the design of the application.

The objective of the functional requirements is to list explicitly all the functions that the application should be able to perform. Most of these are related to:

1. The form and sources of data input used with the application.

2. The reports and data transfers to other functions required from the application.

3. The particular analyses required from the application (such as FIFO or LIFO inventory costing, or maintenance scheduling procedures).

4. The interconnections required between the application and other automated functions in the agency.

5. The specifics of hardware on which the application will be used, and any software with which it should have to work.

Data input information describes the processes used to collect data and enter it in the program. Forms used to collect data should be included. Coding systems used on the forms should be described. Data may be entered in the program in an interactive or real time mode, where the user records the event or transaction into the computer as it takes place, or in a batch mode where an employee collects paper records for the day or week and enters them all together. In some situations data required for the application may be available from another program's computer files, which should be identified.

The functional requirements should be very specific about the different reports required and the information that should be included on each. The description should include the purpose of the report, how often it is needed, and information that the report should include.

Analysis procedures vary between agencies. It is important that the functional requirements for an application specify the analysis procedures that are required. For example, inventory valuation may be done using a first-in, first-out (FIFO), last-in, first-out (LIFO), or average cost method. Ridership may be summarized by average weekday or by day of the week. These specific techniques used by the agency may influence the choice or design of software. Existing programs may or may not be able to handle the analysis strategies in use. If a new or modified program is being developed, the analysis in use may affect the program design.

Additional applications may have to work together with other existing or new applications. These constraints affect the design of new applications. Input to a task may be in the form of data produced by another program. For example work order data produced by a maintenance management program may also provide information on parts use for inventory tracking. Likewise, the output of the new application may be useful as input to other tasks. A bus stop inventory program may be useful in analysis of on-off counts by stop.

The microcomputer system in use, including both hardware and software can constrain the development of an application. Memory capacity, storage facilities, and processor in use will all help to shape the application design. Existing software may also limit or guide the strategy for new application development.

Sources of information that are helpful in identifying functional requirements include:

1. A careful review of all analysis, reports and procedures currently done manually.

2. Ideas for additional analyses or procedures that are not currently done, but desired as improvements.

3. A review of computer applications or procedures used by peer agencies.

4. A review of application packages on the market to perform the specific task.

Working with a Programmer

One of the challenging aspects of having a program custom-developed or modified is working with the programmer. This relationship can be shaped by preparing the specifications and contract for the project carefully. Four important aspects of the project to address are:

1. Full description of services required from the programmer.

2. Division of responsibility between agency staff and the programmer.

3. Project elements and schedule.

4. Legal requirements and financial arrangements.

Most programming projects benefit by the programmer providing support through the installation of the program. This involves services beyond the programming itself, including involvement in installation, testing for errors, monitoring a test period, training of agency staff, and documentation of the package. These functions, while not specifically technical, benefit by the involvement of someone very familiar with the program, and are essential to the successful introduction of the new package. Each of these tasks should be described in the contract.

The complex interactions between agency staff, familiar with the procedure being automated, and the programmer, familiar with the technical aspects of the application, should be clarified as much as possible. Functional requirements prepared in advance by agency staff will need to be enhanced by detailed conversations between the program's end-users and the programmer. Agency staff should have an opportunity to review detailed descriptions of each program component as it is developed. Installation of the application may involve inputting large amounts of data; this can be done by agency staff, or an outside contractor, but should be specified in advance.

One of the difficult aspects of programming projects is keeping them on schedule. A good place to start is to break down the project into subcomponents and establish completion dates for each element. Most programming tasks can be broken into subelements that can be tested independently. These and the phases of application planning and installation can provide bench-marks for scheduling. It may be desirable to establish a penalty for late completion of the project.

Various items should be included to provide legal protection for the agency. The contractor should certify that he or she has the license to distribute any preprogrammed software being purchased through the contract. Warranties should be included that the program will perform the application as specified and that it will be free from bugs and errors. A performance bond may be required. Payment terms and conditions should be specified.

System Management

As the system is developed, increasingly formal coordination mechanisms will have to be provided. There are several reasons for needing increased system management:

1. Hardware use is likely to require coordination.
2. Increasingly complex applications will be developed, requiring interaction between different users and several applications.
3. With greater use of the system, priorities may have to be set and equipment allocated between users.
4. Standards for documenting applications developed in-house may need to be established and enforced.
5. Support for the system, including purchasing of supplies and identification of reference sources and periodicals, must be organized.

Hardware Coordination

Some pieces of equipment are used by many users and require management. This applies particularly to hard disks, whether they are used by several people or shared by several microcomputers through a network.

When valuable or sensitive data is being stored on a hard disk, a security system of passwords may be required that is maintained by the system manager.

Memory on hard disks is shared by different applications. If several staff members are all using disk storage, one person should be responsible for keeping track of disk use. This will allow efficient use of the memory, reduce duplication of data on the disk, and ensure that the location of data is properly documented. Separate portions of the disk or the directory may be allocated to different users, applications, or programs.

If a network is used to allow users of several different microcomputers to share data on a hard disk still more management is required. Most networks provide some control over what users have access to what data or equipment. This is done through a system of passwords. It is essential to have one individual responsible for coordinating this type of system.

Often data is stored on hard disks that should not be read or changed by all users of the system. When this is the case, a security system can be used to protect data. The most common form of security uses passwords assigned to different staff members. Each password controls access to different data items, by preventing access altogether, allowing the user to read data, or allowing the user to change data. Such a system must be administered by the system manager to be effective. A policy identifying appropriate levels of access for each data item is required. In addition the system must be kept up-to-date as new users or data are added, and passwords should be changed periodically.

Application Coordination

As use of the system becomes increasingly sophisticated, more applications will be introduced that do not stand entirely on their own. Data may be passed from one to another. The same data items may be used for several purposes by different users. These factors introduce a new level of complexity to the system. Increasingly a coordinator will be required to ensure that the various applications work smoothly together.

The most basic issue in coordinating applications is ensuring that the structure of data files takes into account possible multiple uses of the data. This may mean that a single file of data contains more data than is required for either application by itself, but reduces the need for common information to be duplicated.

Logistical considerations may also have to be addressed in coordinating applications. Different users who need the same data may both need access to the same hard disk containing the information. Alternatively, the data can be copied routinely onto a floppy diskette for each user. Security arrangements may be required to limit access to data or prevent damage by accidental or unauthorized data changes. Most of these issues can be addressed by fairly simple arrangements; however, some central individual must be responsible for dealing with them.

Priority Setting

As the system becomes more intensively used, and pressure increases to expand and add new applications, the system manager is needed to set priorities. This could be as simple as preventing unproductive uses of computer time. Competition for access to microcomputer resources may become stiff, and practical reasons for microcomputer use are complicated by issues of prestige and fascination with the technology.

The placement of newly acquired equipment must be decided. As in Phase 2, the problem is to maintain a balance between accessibility to all users and convenience. Microcomputer workstations should almost always be located in common areas, accessible to all users in the area. Very rarely can a personal workstation, assigned to only one staff member, be justified. Similar decisions must be made about the location of peripherals, particularly printers.

Priorities must also be set for new applications to be developed. It is generally a good strategy to add new applications one at a time to control the level of confusion and limit the allocation of resources to application development. This can be done by implementing the automation plan. The system manager can be effective in ensuring that the plan remains a guideline as the system is developed.

Documentation Standards

An important element in the long-term usefulness of an application is the documentation that supports it. Documentation allows new users to learn how to use it and to modify it as the agency needs change. Unless adequate documentation is prepared, the application may become useless to remaining staff when the developer leaves the agency.

Support

Ongoing support to system users greatly enhances the usefulness of the system. Users of the microcomputer can continually benefit from learning new ways of using the system or doing their task. Specific questions concerning problems encountered also need to be addressed.

There are many resources available for supporting microcomputer users, but they need to be made accessible to agency staff. In some situations the system manager or another staff member may have sufficient expertise to provide support to other agency users, although this type of support can be very time-consuming. Periodicals and newsletters are also an inexpensive source of information and ideas on using microcomputers. The community may also offer resources such as usergroups that can provide reference services. The system manager can act as a broker for this type of information.

Staff training is also an ongoing need. User's needs may become more specialized as their sophistication increases. Training can be a one-on-one session with an experienced user or it can be a structured course, either in-house or in the community. A system manager can identify training needs as they develop, and determine the appropriateness of training alternatives.

APPENDIX A

GLOSSARY

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GLOSSARY

Address bus. The path used by the CPU to identify locations in memory.

Application program. A program designed to perform a practical task, such as accounting, parts inventory, or route costing.

ASCII. American Standard Code for Information Interchange. A standard for representing the characters of the alphabet, numerical digits and punctuation in binary code (1s and 0s.)

Asynchronous port. Same as serial port.

Auto dial, Auto answer modem. A programmable modem which can store and dial telephone numbers or answer incoming calls without user involvement.

Backup. A copy of a program or data made for protection in case the original is damaged.

BASIC. Beginner's All-purpose Symbolic Instruction Code. An easy-to-learn, high-level programming language, much used on microcomputers.

Baud rate. Rate of data transfer over telephone lines in bits per second. Standard rates are 300 and 1200 baud.

BIOS. Basic Input Output System. Part of the operating system which controls input and output devices attached to the computer, including the keyboard, monitor, and printer.

Bit. Binary Digit. The smallest division of computer data, either 1 or 0.

Bit size. The number of bits processed as a group by a CPU microprocessor.

Board. A resin board holding chips and circuitry which enhances the computer's operation. Boards can be purchased as an option and plugged into one of the computer's expansion slots.

Boot. To turn on a computer and load the operating system into memory, preparing it for use.

Buffer. Memory used as temporary storage for data being transferred between the computer and a peripheral.

Bus. A path over which data travels between parts of a computer system.

Centronics. The standard connection for parallel communication.

Chip. A tiny integrated circuit etched on a silicon wafer. A chip can be a microprocessor or memory.

Clock speed. The speed at which a microprocessor operates, measured in megahertz or millions of cycles per second.

Command. An order to the computer to execute a task.

Command-driven. A program used by giving commands known by the user, rather than by selecting from a menu.

Compiler. Software which translates a program written in a high level language (source code) into binary object code understood by the CPU.

Controller. A microprocessor which coordinates a peripheral device (printer or monitor, for example) with the CPU.

Coprocessor. A microprocessor used to supplement the CPU by performing specialized tasks.

Copy protection. Techniques used by software distributors to prevent unauthorized copying or distribution of their programs.

CPU. Central Processing Unit. The microprocessor that does the actual computing and controls the flow of information in the computer.

CRT. Cathode Ray Tube. A video display monitor.

Cursor. A marker which moves around the monitor screen to show you where you are in the text or program.

Daisywheel printer. An impact printer using raised inverted letters at the end of the petals of a metal or plastic "daisy".

Database. A collection of information, organized for easy analysis and retrieval. May be a group of files.

Database manager. A program which allows the user to organize, build, and use a database.

Data transmission adapters. Devices which permit the computer to transmit data to and receive data from peripheral devices by using a predefined format.

Debugger. Software which helps a user to identify and correct program errors by following the detailed operation of the program.

DIF. Data Interchange Format. A standard format for data, permitting transfer of data between programs which use the DIF standard.

Disk, diskette, floppy disk. A plastic magnetic disk which is the most usual medium for recording and storing data.

Disk drive. A piece of equipment which reads data from and writes data on a disk as directed by a program and the CPU.

Documentation. The material which accompanies the program to teach the user how to use it and provide information for future reference.

Dot matrix printer. A printer which forms letters and images from rows and columns of tiny dots.

Erasable Programmable Read Only Memory. (EPROM) Memory which is not erased when the computer is turned off, and which can be programmed and erased by users.

Error trapping. A method for checking input to a program by comparing data with acceptable or unacceptable input values and rejecting unacceptable data with a message to the user.

Electroluminescent display. A display used on some portable computers in which characters are formed by wires which glow when current is passed through them.

Expansion slot. See slot.

File. A collection of data treated as one unit which can be a program, a piece of text, or statistical information.

File Manager. A program which allows the user to organize, build and use a file of data.

Fixed, hard, or Winchester disk. A permanently installed metal magnetic disk capable of holding large amounts of information, and rapid reading and writing of data.

Format. A pattern of subdividing a disk to organize the information written on it. Also a standard way of writing data so that it can be understood by a program.

Full-duplex modem. A modem permitting data to be transferred to and from it simultaneously.

Generic software. Programs which can be used as a multi-purpose tool, rather than having a specific application. Word processors, spreadsheets or database managers are common examples.

Half-duplex modem. A modem which can only transmit or receive data at a time.

Half-height. A compact design for disk drives, half the volume of the standard size.

Hard copy. Program output printed on paper, as opposed to that displayed on the monitor.

Hard disk. Fixed disk.

Hardware. The physical components of the computer, as opposed to the programs or software.

High level language. A computer language using English-like words, which must be translated by a compiler or interpreter before the CPU can understand it.

Ink jet printer. A printer which prints characters by shooting ink out of a grid of tiny nozzles.

Integrated programs. Programs which perform different functions but are designed to be used together as a package.

Interpreter. A program which translates a high-level language program into machine language step by step as it runs.

Kilobytes. (K) About 1000 bytes of memory.

Keyboard. A device resembling a typewriter keyboard used for input of information to the computer.

Letter quality printer. A printer which produces text of the same quality as an electric office typewriter.

Light pen. A device used to identify points on the monitor screen.

Liquid crystal. A type of display found in small computers where liquid is darkened by applying an electric field to it.

Local Area Network. (LAN) A system of hardware and programs for connecting microcomputers to each other and allowing them to share peripherals.

Megabyte. One million bytes, approximately.

Machine Language. The language made up of 0s and 1s is understood by the CPU.

Macro. A series of spreadsheet commands, stored and executed as a group.

Mass storage. Peripheral devices, such as disk drives, used to store data.

Menu. A list of options displayed by the program from which the user can select a command.

Menu-driven. Programs which are operated by the user selecting from menus of choices.

Microprocessor. A chip which performs computations or controls information flow, such as the CPU.

Modem. Modulator-Demodulator. A device which translates data from a computer's serial port into modulated signals to be sent over a telephone line and converts incoming signals back into a form understood by the computer.

Monochrome. A monitor which displays tones of a single color.

Mouse. A device which the user rolls across a desktop to move the cursor.

Monitor. The television-like display used for viewing computer output.

Multi-processor. A computer containing two microprocessors which can be selected as alternate CPUs.

Multi-tasking. A computer which can perform several tasks at one time by dividing CPU time between them.

Multi-user. A computer which can be used by several operators at a time from separate keyboard terminals.

Object code. The form of a compiled program in machine language which can be executed by the computer.

Off-the-shelf. Software which is widely commercially distributed and can be purchased at computer stores.

Operating system. A master program which allows the computer to run other programs by controlling flow of data between the CPU and peripherals.

Optical scanner. A device which reads special markings, such as bar codes, for direct input to the computer.

Network. See Local Area Network.

Package. A group of programs distributed as one product.

Parallel port. A port which transmits 8 bits of data, or a byte, simultaneously.

Peripherals. Devices which are plugged into the computer, such as disk drives and printers.

Pixel. A dot on a monitor display, many of which make up the image.

Port. An outlet through which the computer can communicate data.

Printer. A device which prints computer output on paper, creating hard copy.

Program. A collection of commands to the computer to be executed as a group.

Programmable read only memory. (PROM) Blank read only memory which can have a program written on it permanently.

Protocol. Standard conventions which allow two computers to coordinate communications.

Random access memory. (RAM) Internal memory on chips which is erased when the computer is turned off.

Read only memory. (ROM) Permanently programmed memory which holds programs installed by the computer manufacturer.

Resolution. The quality of image on a monitor display, affected by the size and number of dots or pixels on the display.

Record. A collection of information treated as a unit. A number of records make up a file.

RS-232-c. The standard for serial or asynchronous ports.

Sector. A portion of a diskette treated as one unit for reading and writing data.

Serial port. A port through which data is transmitted one bit at a time. Signals are used to indicate when each byte, or group of 8 bits, stops and starts.

Slot. An outlet on the bus for plugging in boards containing additional memory, controllers or other enhancements of the computer.

Software. Programs and languages used with a computer system.

Source code. The text of a program in a high-level language.

Spooler. A program which designates some portion of RAM to serve as buffer for temporary storage of material to be printed.

Spreadsheet. A program used to set up and manipulate large tables of information.

Surge protector. A device placed between the wall outlet and power cable of the microcomputer to protect the computer from damaging voltage surges.

System software. Software supporting application programs, including the operating system, programming languages and utilities.

Text editor. A program which allows the user to enter and change text stored in a file.

Text formatter. A program which allows the user to format text for printing by controlling margins, page length, indentation, and so on.

Thermal printer. A printer which forms images by heating points on heat sensitive paper.

Thimble printer. An impact printer which uses raised inverted letters on "thimble" shaped piece.

Track. A concentric circle on a disk used for defining and locating storage sections on a disk.

Tutorial. A simulated application of a program provided to introduce users to the program.

Utilities. Programs used to enhance the use of the computer and increase control and flexibility of computer use.

Winchester disk. Fixed disk.

Window. An area of the monitor screen used to display different applications or portions of the same application.

Word processor. A program for entering, editing, and formatting text documents.

APPENDIX B

REFERENCES

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REFERENCES

Transit Industry Microcomputer Exchange (TIME)

The Transit Industry Microcomputer Exchange is a federal sponsored microcomputer users group. They publish a newsletter, "TIME Capsule," and distribute public domain software developed by other users. Their address is:

TIME Support Center
Rensselaer Polytechnic Institute
Civil Engineering Department
Troy, NY 12181
(518) 266-6227

TIME distributes, free of charge, a selection of publications related to microcomputer use in transit. They include:

Companions to this Handbook

- Microcomputers in Transit: A Hardware Handbook
- Microcomputers in Transit: A Software Handbook

Background on microcomputers in transportation

- Selected Readings Volume 1: Getting Started in Microcomputers
- Selected Readings Volume 2: Selecting a Single User System
- Selected Readings Volume 3: Addressing Organizational Issues

Documents on needs assessment and implementation

- An Approach for Mircocomputer Needs Assessment: Greater Polland Transit District
- Microcomputer Implementation at Lowell Regional Transit Authority
- Microcomputer Training for Transit Managers
- Sample Requests for Proposals
- Sample Microcomputer Policy Statements

Information on Applications

Microcomputers in Transportation Software and Source Book

An Example of a Microcomputer Bus Schedule Database

Improved Decision-Making Power for the Transit Maintenance Manager

Technology Sharing

Technology Sharing has distributed several reports related to microcomuters in transit. They are:

Microcomputers in Transit: A Hardware Handbook (by the Institute for Urban Transportation), document DOT-I-84-46

Microcomputers in Transit: A Software Handbook, (by the Institute for Urban Transportation), documtne DOT-I-84-47

Financial Planning in Transit: Use of Commercially Available Microcomputer Software, document UMTA-MA-06-0039-83-1

Use of Microcomputers at North County Transit District, document DOT-I-85-14

Commercial Software Applications for Paratransit, document DOT-I-84-51.

These reports can be obtained free of charge by sending a self-addressed mailing label and specifying the title and document number to:

Technology Sharing
Office of the Assistant Secretary for Governmental Affairs
U.S. Department of Transportation
Washington, D.C. 20590

National Cooperative Transit Research and Development Program (NCTRP)

An inventory of software on all computers at transit agencies is being conducted for NCTRP. For information on the status of this project contact:

Mr. Ian Kingham
Projects Engineer
Transportation Research Board
2101 Constitution Avenue, N.W.
Washington, DC 20418
(202) 335-3224

Periodicals

Numerous periodicals are available which offer various perspectives on the microcomputer industry and uses. They are particularly helpful for comparative reviews which describe the use and attributes of the type of product. Reviews of specific products vary in usefulness, depending on the willingness of a particular periodical to honestly describe a product's shortcomings.

Some of these periodicals are obtained by most public libraries and they are widely available at newsstands.

General Magazines

Magazines which deal with the industry as a whole, without focusing on particular types of product are helpful for becoming familiar with the technology and its uses. Once a type of microcomputer has been selected they become less helpful, because material on other types of microcomputers may not be relevant.

Personal Computing is a readable general magazine which is helpful for its general discussions of computer uses and products. Monthly. $18/year.

Personal Computing
P.O. Box 2942
Boulder, CO 80322

Popular Computing is a readable general magazine which has useful overviews of product types and applications. Monthly. $15/year

Popular Computing
P.O. Box 307
Martinsville, NJ 08836

InfoWorld is a newsmagazine on the computer industry. Its descriptive no-holds-barred reviews of specific software and hardware products are particularly useful. Weekly. $31/year.

Info World
375 Cochituate Road
Framingham, MA 01701

BYTE is a thorough, more technically oriented magazine. It contains comprehensive discussions of product types and ways of using microcomputers. Monthly. $21/year.

BYTE
P.O. Box 590
Martinsville, NJ 08836

Product-Specific Magazines

If you have selected a particular type of microcomputer it is helpful to obtain one of the magazines specific to a microcomputer type. Because of their well-defined focus these offfer techniques and suggestions of immediate value in using the microcomputer and help the reader to understand and explore the range of abilities of the machine.

For the IBM PC and compatibles:

PC World. Monthly.

PC World
555 De Haro Street
San Francisco, CA 94107

PC Magazine. Bi-weekly.

PC Magazine
PC Communications Corp.
One Park Avenue
New York, NY 10016

For Apple microcomputers:

nibble. Monthly.

nibble
P.O. Box 325
Lincoln, MA 01773

Business Computer Magazines

A number of periodicals treat the use of computers within organizations. In addition to the technical aspects of automation these magazines discuss issues of management, personnel, and decision-making in relation to computers. Many of them include microcomputers as well as larger computer systems. Two of these are:

Business Computer Systems
270 St. Paul Street
Denver, CO 80206

Monthly, free to business personnel
responsible for computers.

Computer Decisions
P.O. Box 1417
Riverton, NJ 08077

16 issues/year. Free to executives
of organizations that use computers.

Software Reviews

An independent service which reviews software for the IBM PC is Software Digest Ratings Newsletter. Each monthly report covers one type of software, and rates programs on a variety of criteria. Monthly. $135/year.

Software Digest
One Wynnewood Road
Wynnewood, PA 19096

☆ U.S. Government Printing Office: 1986—491-810/20688

DOT-I-86-07

TECHNOLOGY SHARING

A PROGRAM OF THE U.S. DEPARTMENT OF TRANSPORTATION